September 1976
Volume 20
Number 5

Mariners Weather Log

National Oceanic and Atmospheric Administration • Environmental Data Service

U.S. DEPARTMENT OF COMMERCE
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Cover: Ice conditions encountered by the Alaskan Arctic oilfield resupply barges during 1975. That year was considered the most severe since records began in 1953. For an annual ice severity index since that date, see table on page 275. Photo courtesy of Helen L. Atkinson.

Mariners Weather Log

Editor: Elwyn E. Wilson
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September 1976
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Washington, D. C.

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The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical approved by the Director of the Office of Management and Budget through June 30, 1980.

Copies are available to persons or agencies with a marine interest from the Environmental Data Service, D762, Page Building 1, Room 400, Washington, D.C. 20235. Telephone 202-634-7395. Telephone 202-634-7394.

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Mariners Weather Log

COMPUTERIZED TROPICAL CYCLONE CLIMATOLOGY

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During the past 8 yr operational procedures at the National Hurricane Center have become increasingly computerized. Today, computers perform a variety of tasks such as plotting and analyzing weather maps, formatting weather messages, preparing forecasts, and processing data. Several years ago, Hope and Neumann (1971) discussed some of the computerized techniques then in use at the Center. Figure 1, taken from this reference, shows a computer plot of 680 recorded Atlantic area tropical cyclone tracks for the years 1886 through 1969. This is an excellent example of a computer's ability to perform a task that would be virtually impossible to duplicate using conventional procedures. In recent years the National Hurricane Center has made additional advances in computer application. This article will attempt to illustrate some of these new techniques as they relate to tropical cyclone climatology.

The tropical cyclone tracks illustrated in figure 1 have been augmented with additional years of data. Including the 1975 hurricane season, 743 tropical cyclone tracks now make up the historical record dating back to 1886. Information is also available prior to this date, but it is too sketchy to be of significant operational value. As was pointed out by Hope and Neumann, it is mainly from ship reports that this long record of tropical cyclone activity is available. In recent years these ship data have been supplemented with aircraft reconnaissance and satellite data. However, the National Hurricane Center still considers

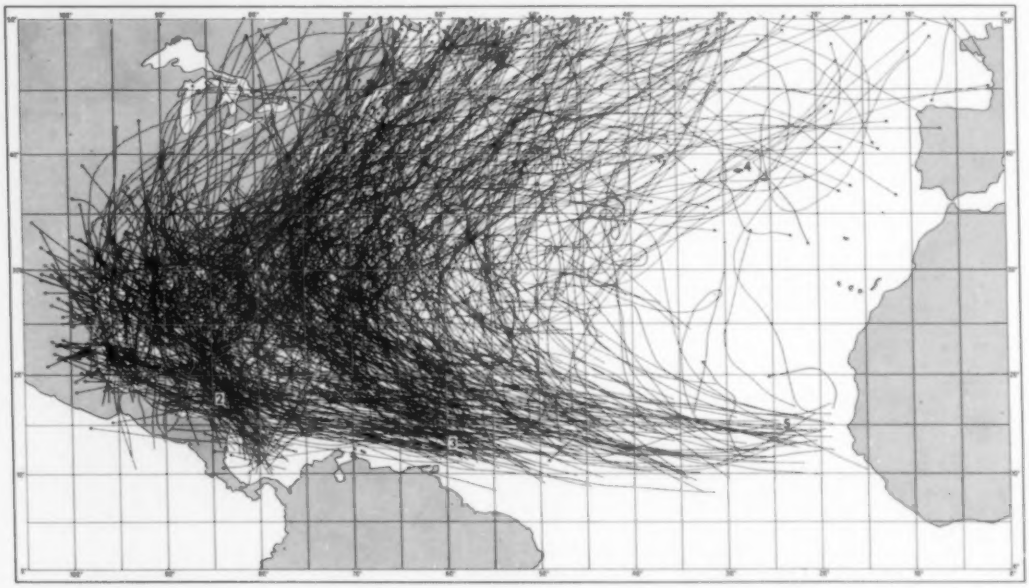

Figure 1.--Computer plot showing the tracks of the 680 recorded Atlantic tropical cyclones, 1886 through 1969 (After Hope and Neumann 1971).

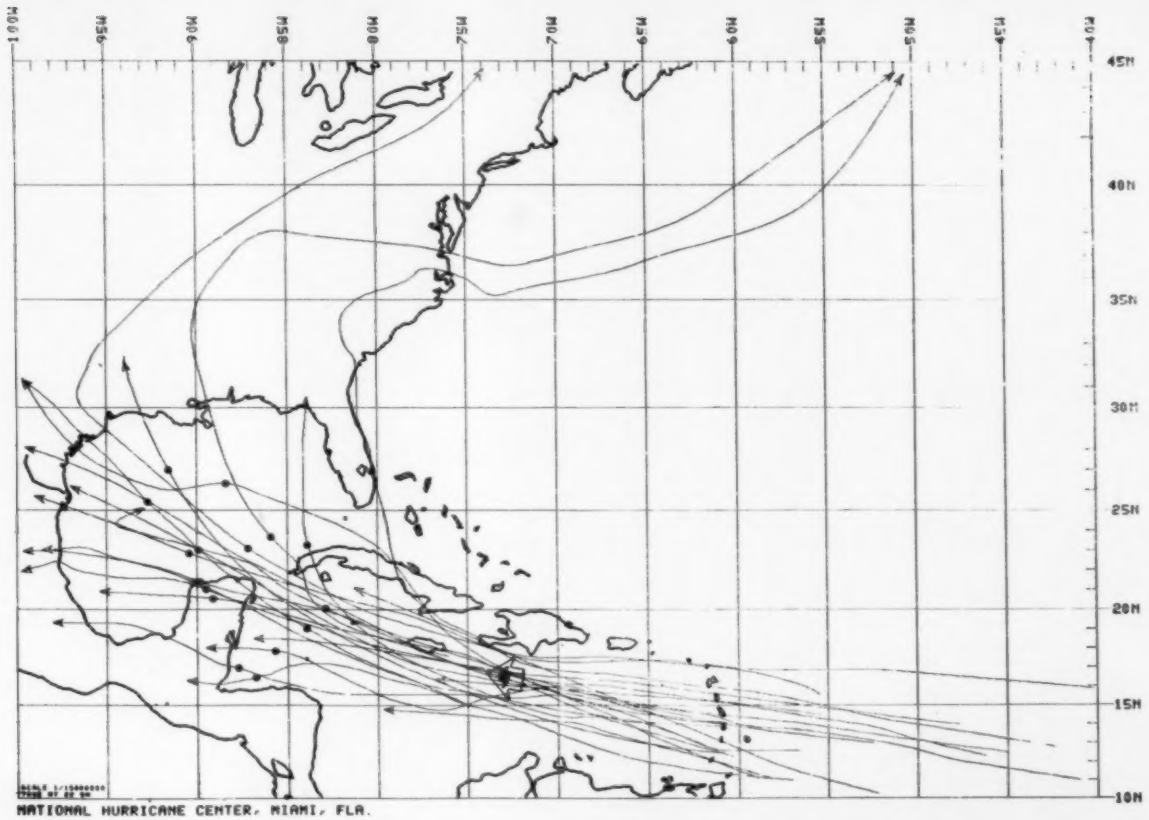

Figure 2.--Computer plot of "analog" storms. Hurricane symbol and arrow show location and motion of current storm. Darkened circles farther westward show location of analog storms after 72 hr.

ship reports to be an important source of information relative to its responsibility in the detection, tracking, and forecasting of tropical cyclones.

Storm track data, similar to that shown in figure 1, for all tropical cyclone regions of the world are maintained at the NOAA Environmental Data Service, National Climatic Center, in Asheville, N.C. Using this data source, Crutcher and Quayle (1974) have published a worldwide atlas of tropical cyclone activity. (See Mariners Weather Log, September 1974, page 314.) Preparation of such a document would be virtually impossible without computer assistance.

The National Hurricane Center is essentially a forecasting rather than a data collection agency. Pursuant to its forecasting responsibility, however, the Center maintains detailed computer files of historical Atlantic area tropical cyclone activity. Some of these data form an integral part of certain statistical forecasting models in use at the Center. They also provide answers to some of the thousands of inquiries received annually at the National Hurricane Center for information relating to tropical cyclone climatology.

The ability to rapidly recall and display storm tracks provides the hurricane forecaster with important decisionmaking information relative to a given forecast situation. Suppose, for example, a storm is initially located south of Hispaniola on August 15 and moving slightly north of due west at 15 kn. Through the use of a single punched computer card, the forecaster asks the computer to scan the historical storm data file, to identify those storms with characteristics in common with the current storm, and to plot those storms so identified on a Mercator map of some specified scale. The computer identifies 22 such storms. The plot which is produced for the forecaster in but a few minutes is shown in figure 2. In this example, the forecaster has also elected to have the computer mark the position of each of these 22 "analog" storms after 72 hr. The computer also suggests a forecast position of near 22.2°N, 87.2°W. The procedure is adopted from the HURRAN (Hurricane Analog) method described by Hope and Neumann (1970). Such information is extremely valuable to the hurricane forecaster in that it effectively defines "normal" behavior of storms in this area for mid-August. The forecaster then makes modifications to this normal behavior as warranted by other objective and subjective procedures in effect at the National Hurricane Center.

The computer program that produced the storm tracks shown in figure 2 has the potential of providing

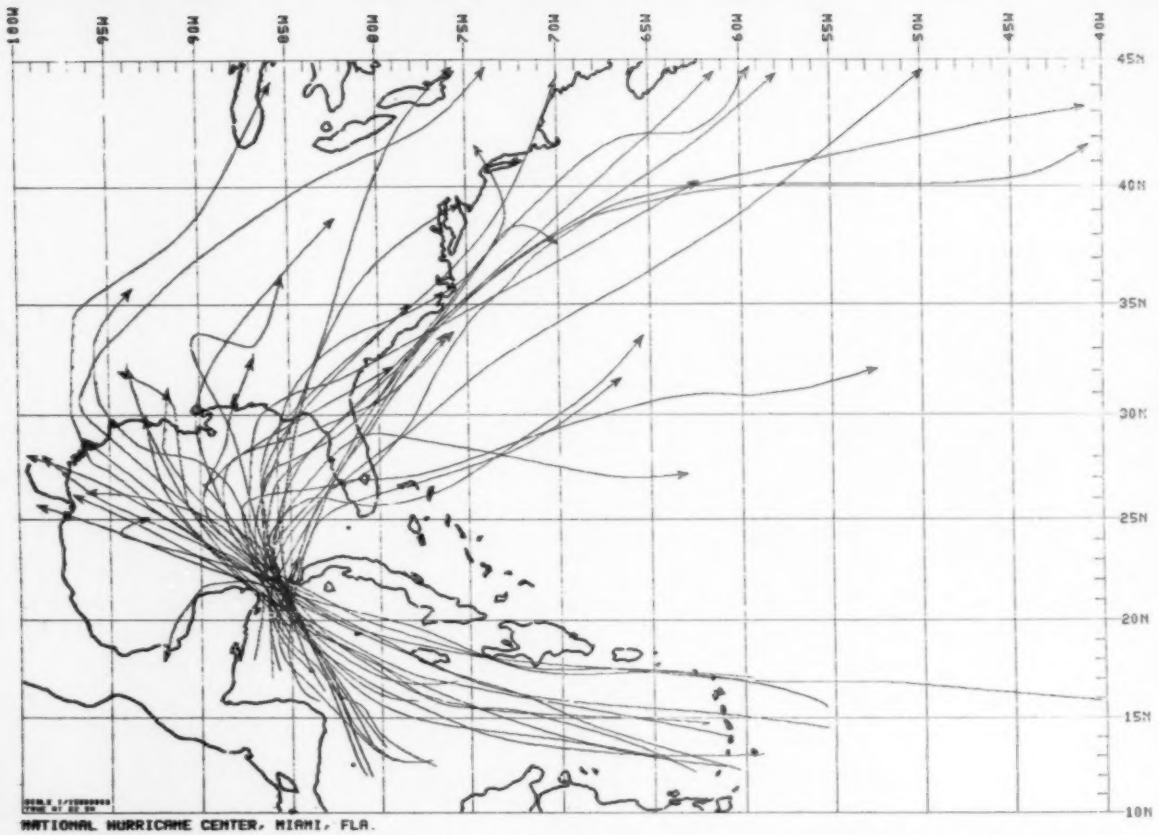

Figure 3.--Computer plot showing tropical storms and hurricanes passing through the Yucatan Channel, 1886 through 1975.

a variety of other storm track information. Some of this may be of interest to mariners. For example, the program can be called upon to plot all of the tropical storms and hurricanes of record that have passed through the Yucatan Channel on their way from the Caribbean Sea to the Gulf of Mexico. For this problem, the computer must be given the latitude and longitude coordinates of the Channel as well as the direction of motion of the storms to be considered. The computer plot showing the 39 storms meeting these criteria is shown in figure 3. Note that these storms eventually affected the Gulf Coast all the way from Mexico to Fort Myers, Fla. Additional computer printouts, not illustrated here, show that early- and late-season storms passing through the Channel have a considerable northerly component of motion and tend to affect the eastern Gulf. On the other hand the midseason storms originate farther east in the

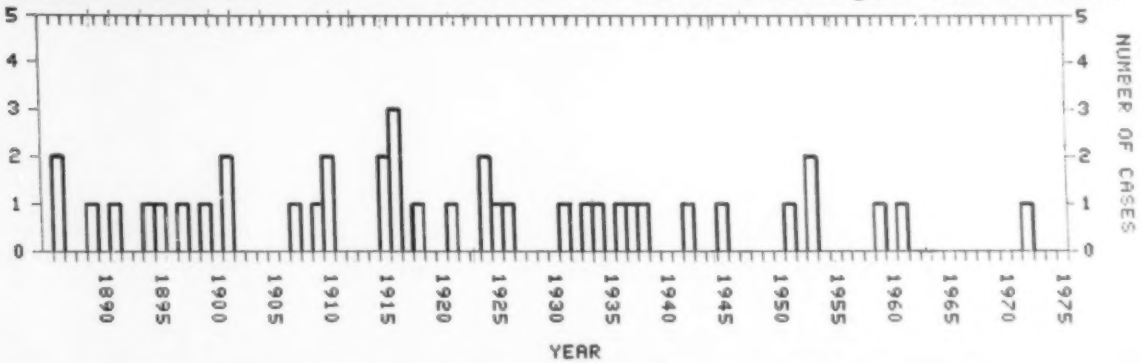

Figure 4.--Yucatan Channel storms identified as to year of occurrence.

Caribbean or Atlantic and pass through the Channel with more of a westerly component of motion, eventually primarily affecting the western Gulf. These two groups of storms can readily be identified in figure 3.

The same program can be called upon to print out such information as the year of occurrence of each storm. Figure 4 shows the number of storms passing through the Channel each year between 1886 and 1975. Note that the frequency of these storms has been somewhat less after 1938.

Other options of the computer program relate to plotting storms passing within any specified distance from any site, over any time period. For example, the computer was asked to plot the tracks of all tropical cyclones passing within 60 mi of the center of Puerto Rico over the entire hurricane season. The

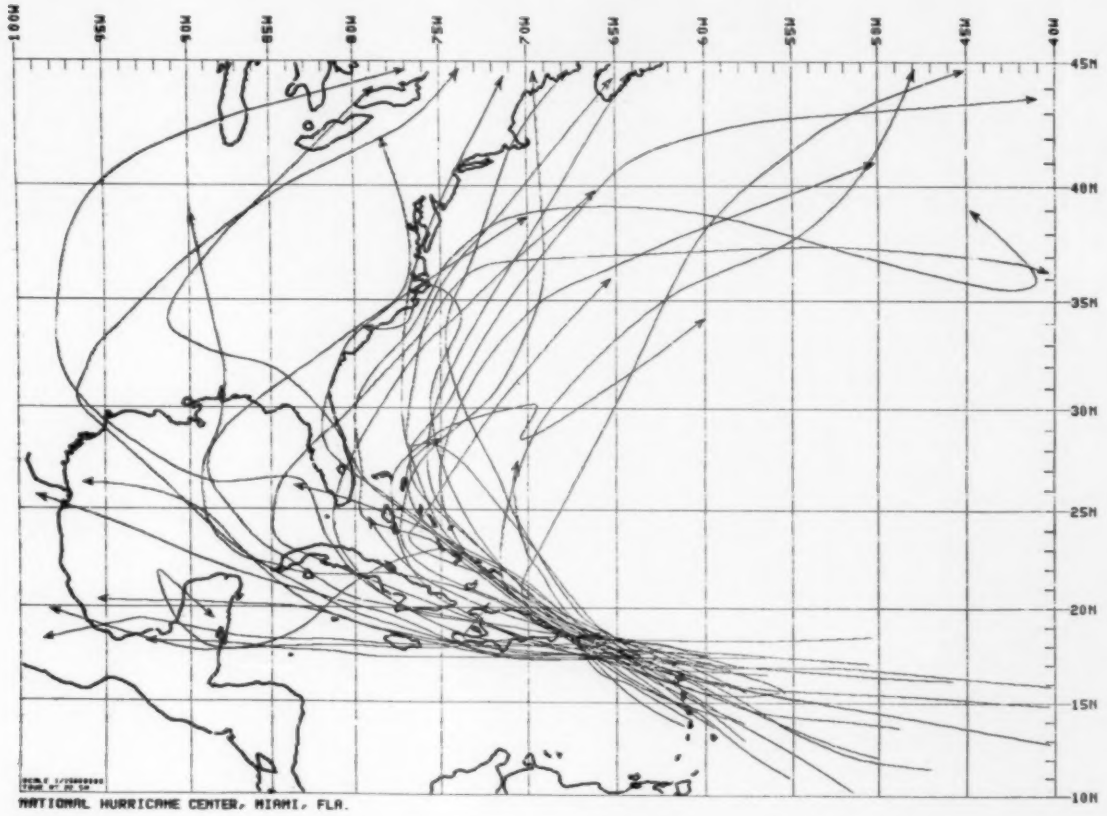

Figure 5.--Tropical cyclones (including depressions) passing within 60 mi of the center of Puerto Rico, 1886 through 1974.

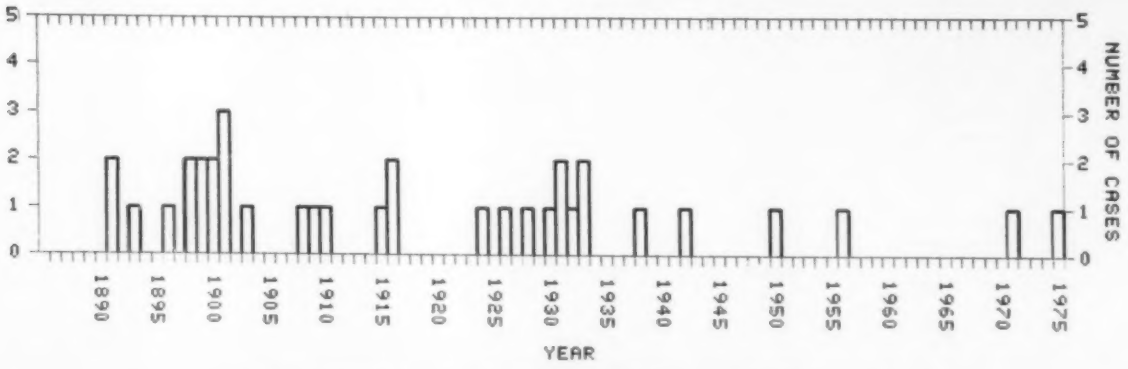

Figure 6.--Puerto Rican storms identified as to year of occurrence.

tracks of the 35 storms so identified (except for Eloise, 1975) are plotted in figure 5. Note that after passing over or near the island, the storms followed widely diverging paths extending all the way from Honduras due west of Puerto Rico to the open Atlantic to the northeast. A computer plot showing the years of occurrences of these 35 storms is shown in figure 6. It is interesting to note that only six of these storms occurred since 1933.

The program which produced figure 5 has been run for all of the major coastal and just inland cities along the entire coast of the United States as well as for Mexico, Central America, and the Caribbean. Figure 7 shows the number of tropical cyclones of any intensity passing within 60 mi of each of these cities. The original storm count included storms which occurred over the 90-yr period 1886 through 1975. However, the computer was programmed to increase the frequencies by 11 percent in order to simulate a 100-yr period. Points of interest relating to figure 7 include:

1. The high frequency of storms (80 per 100 yr) passing near Cape Hatteras. Most of these pass just offshore on a north-northeasterly heading.

2. The low frequency of storms (17 per 100 yr) passing near Camaguey, Cuba. This relatively storm-free area can be seen in figure 1. It is related to the orientation of the Greater Antilles.

3. The increase in storm frequency along the Gulf of Mexico coast from Vera Cruz, Mexico (14 per 100 yr), to Fort Myers, Fla. (54 per 100 yr). Note, however, the apparent anomaly in the Lake Charles, La., area (24 per 100 yr).

4. The marked gradient of storm activity between Great Inaugua Island (21 per 100 yr) northeastward to Mayaguana Island (53 per 100 yr).

5. The large number of storms passing near the western tip of Cuba (70 storms per 100 yr).

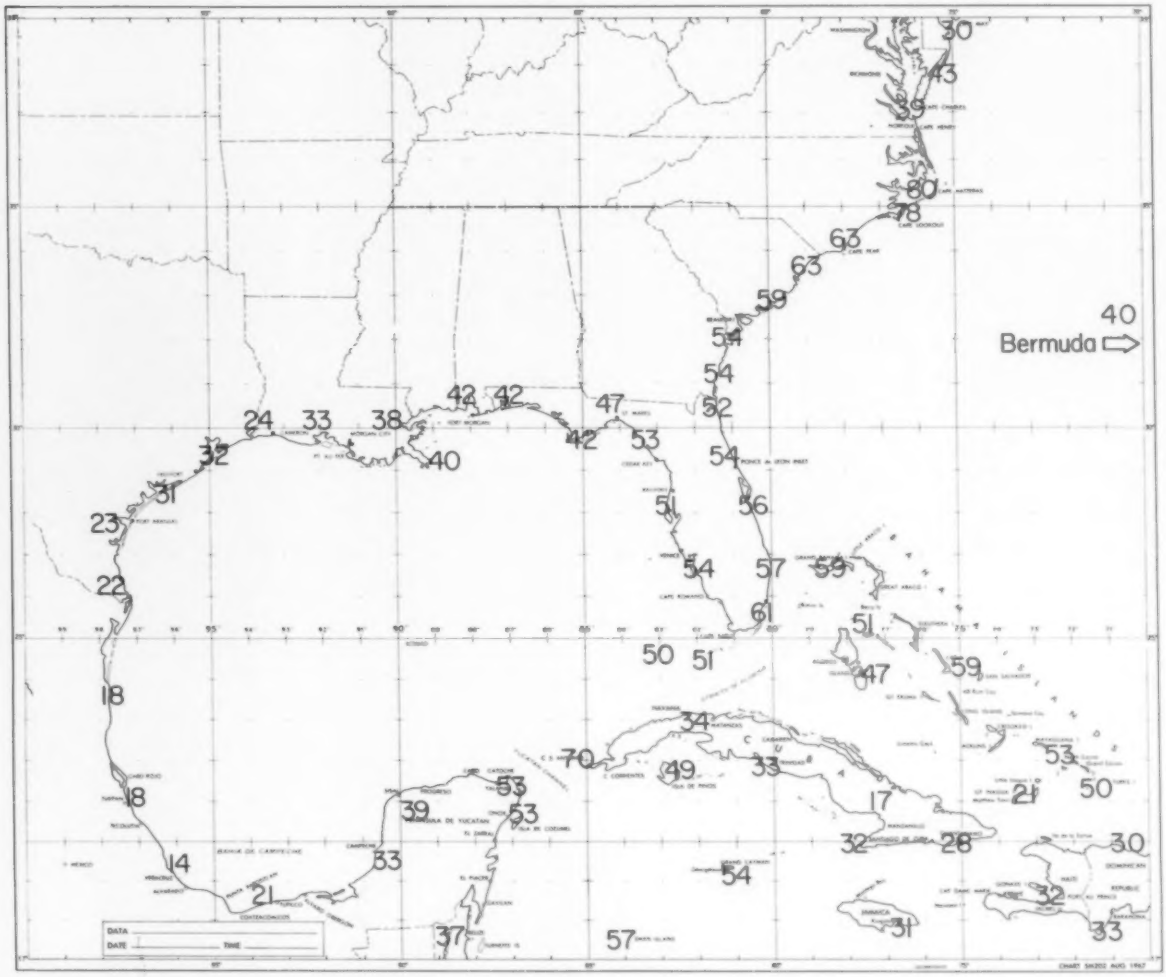

Figure 7.--Number of tropical cyclones (including depressions) passing within 60 mi of specified points in 100 yr.

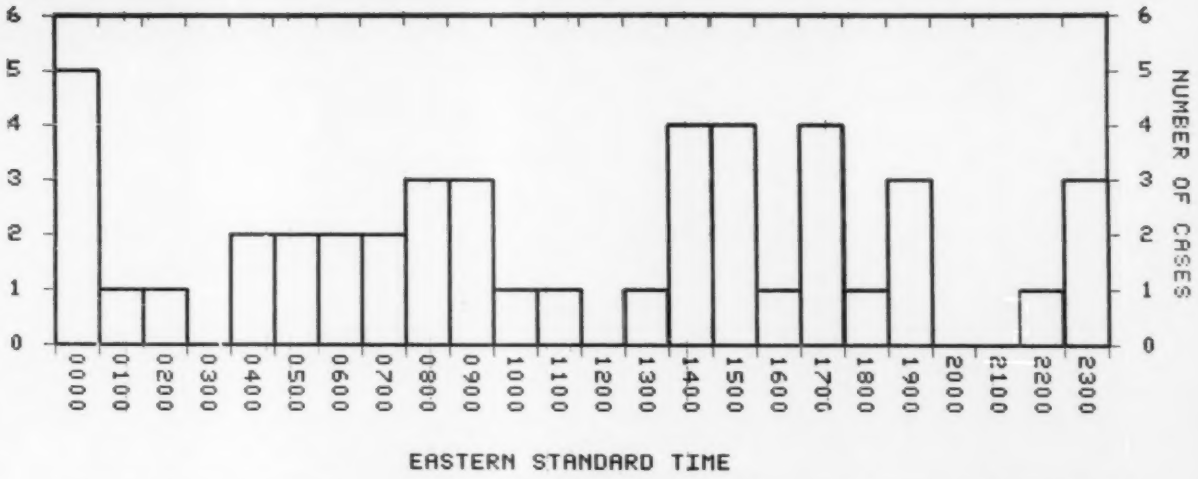

Figure 8.--Diurnal variation of tropical cyclones affecting the Miami, Fla., area, 1886 through 1975.

The data shown in figure 7 were computed without regard to windspeed, and thus do not give the complete picture. The New Orleans area, according to figure 7, experiences 38 storms passing within 60 mi per 100 yr. Most of these storms move in from the open Gulf, to the south, and can be expected to be quite severe. Jacksonville, Fla., according to the figure, experiences a greater number of storms (52 per 100 yr). However, about half of these move in from the southwest and are weakened by their passage over Florida. Most of the remaining storms pass to the east of Jacksonville on a northerly heading which places the city on the weak side of the storm. If desired, the computer can be programmed to distinguish storms which offer a greater threat.

One final example serves to illustrate the objective nature of computer methods. The program utilized to produce figures 5 and 7 also computes the time when each storm was closest to the designated site. In the southern Florida area, recent hurricanes have been most severe at night and early morning. Accordingly, many residents believe that such storms always occur at these times. To see if this is indeed the case, the computer was asked to plot the times when the 45 storms which passed within 60 mi of Miami over the 90-yr period 1886 through 1975 were closest to the city. The resultant plot is shown in figure 8. Here it can be seen that the computer's memory indicates that quite the reverse appears true. There is no meteorological reason why storms should be more likely to arrive at a particular time of day. Given a long enough period of record, it is likely that differences would be insignificant.

These have been but a few examples of how the computer provides the National Hurricane Center with information on tropical cyclone climatology. In cooperation with the NOAA National Climatic Center, the National Hurricane Center is using its computer file of tropical cyclone information to update the out-of-print edition of "Tropical Cyclones of the North Atlantic Ocean" (Cry 1965) which gave the tracks of all recorded Atlantic tropical cyclones through 1963. The revised edition, to appear early in 1977, will contain the tracks of Atlantic area tropical cyclones through the 1976 hurricane season.

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POLAR STAR-NEW COAST GUARD ICEBREAKER

Richard Meidt
United States Coast Guard
Seattle, Wash.

The first U.S. icebreaker to be built in over 20 yr, the U.S. Coast Guard's POLAR STAR (fig. 9), was commissioned in Seattle, Wash., early this year.

The new icebreaker is based in Seattle and will be used primarily to cut supply channels through the Arctic and Antarctic ice to remote military and scientific outposts and also to serve as a floating platform for scientific research.

The POLAR STAR is the first of a new generation of icebreakers. The differences in this ship can be seen in everything from its size and shape to its propulsion system and living quarters for the crew. At 399 ft, the POLAR STAR is the largest U.S. icebreaker ever constructed. The shape of the hull and design of the bow are such that the ship will ride up on the ice and is expected to be able to break up ice up to 21 ft thick. The ship's three propellers (fig. 10) are each 16 ft in diameter and are powered by a 60,000 hp combination diesel/gas turbine propulsion system, making it America's most powerful icebreaker.

Although the ship is much larger than any other U.S. icebreaker, it operates with a smaller crew--about 140. This is because the ship is highly automated and makes extensive use of low-maintenance materials. In the older ships, for example, many people are required to constantly check the operation of the engines, but on the POLAR STAR this is done by computer.

The POLAR STAR is the most liveable ship in the Coast Guard. The larger size and smaller crew have

Figure 9.--The Coast Guard icebreaker POLAR STAR, the first new U.S. icebreaker to be built in over 20 yr, cruises through Puget Sound on a predelivery shakedown cruise. U.S. Coast Guard Photo.

Figure 10.--The immense size of the icebreaker POLAR STAR is readily apparent when the ship is in drydock. The three huge propellors which will drive the ship up onto the ice are each 16 ft in diameter. U.S. Coast Guard Photo.

resulted in tremendous improvement in the quality of living quarters for the crew (fig. 11). Enlisted men share two- and four-man staterooms, while the officers have private rooms which usually double as offices. Living conditions aboard an icebreaker can be critical. Crewmen will be aboard for 6 mo or more at a time, and much of that time will be spent in remote areas of the world. A comfortable place to relax and pleasant surroundings mean a lot when the weeks and months in the ice begin to mount up. In addition to semiprivate rooms, the ship features a library, lounges, gymnasium, and a soda fountain.

The POLAR STAR has a cruising range of more than 28,000 mi, more than once around the world. She is designed to be underway 8 to 10 mo a year, and will use a concept of three crews for two ships when the sister ship POLAR SEA is commissioned next year. This will allow crews to have about an equal balance of sea and shore duty.

Great strides have been made in marine engineering since the construction of the last American icebreaker over two decades ago. POLAR STAR embodies many of these changes--not only in her hull and propulsion system, but also in her scientific research facilities and living accommodations.

In order to appreciate the capabilities of POLAR STAR's hull and propulsion system, it is necessary to understand how icebreaking is accomplished. Rather than colliding head-on with the ice, an icebreaker rides over the ice and then uses its great weight to crush the ice beneath its hull. Because of her unique hull design, POLAR STAR is able to maximize the forces resulting from both her forward motion and the downward pull of gravity. The placement of her frames (the "ribs" of the ship) 16 in apart buttresses the hull against the extreme forces exerted by the ice against the ship. Encasing the hull is plating of specially tempered steel, able to withstand severe polar temperatures and the brutal pounding of the ice. At the ice belt--the area of the hull which comes in contact with the ice--the bow and stern plating is 1-3/4 in thick and tapers to 1-1/4 in amidships.

Unlike older Coast Guard icebreakers, POLAR STAR has a choice of engines to take her through the ice fields. In "normal" icebreaking operations, reliance is placed on six V-16 diesel-electric engines which generate a total of 18,000 shaft hp; heavy ice packs may require the combined 60,000 shaft hp of the three gas turbine engines. In open seas, POLAR STAR can maintain a cruising speed of approximately 17 kn, and at her most economical speed of 13 kn she

Figure 11.--The living conditions on the POLAR STAR are among the finest of any military ship. Long voyages in the desolate polar regions make living conditions for the crew especially important. U.S. Coast Guard Photo.

Figure 12.--The Engineroom Control Center is the heart of the icebreaker POLAR STAR. The completely automated propulsion system is continuously monitored by a computer in the Control Center which scans about 500 areas of engine operations and automatically pinpoints trouble areas. U.S. Coast Guard Photo.

can travel 28,000 mi without refueling. She has a top speed of 21 kn.

Operation of the engines is completely automated; however, three enginemen are always on duty in the soundproofed, air-conditioned Engineroom Control Center (ECC). Located in the ECC is a computer which monitors the propulsion system (fig. 12). About 500 areas critical to engine performance are continuously "scanned" by the computer; if a problem arises, the computer sounds an alarm, shuts down the affected equipment, and instantaneously indicates by a printout the location of the trouble to engineroom personnel.

POLAR STAR is the only U.S. icebreaker to have controllable pitch propellers. The ability to control the angle (pitch) at which the propeller blades cut through the water eliminates the need for reversing direction of rotation of propeller shafts to reverse the propeller thrust. This feature allows the shafts to turn continuously and shortens the time and distance needed to stop the ship.

The three stainless steel propellers offer advantages during icebreaking that are not afforded by the conventional propellers on the older icebreakers. In encountering heavy ice, both POLAR STAR and her predecessors have to reverse their forward movement, "back off," and then "ram" ahead over the ice. The older vessels face the danger that as the direction of propeller shaft rotation is reversed (resulting in a temporary stoppage of the shafts), ice will float up between the hull and propellers, either damaging the blades or impeding their movement. Because POLAR STAR's controllable pitch propellers do not require a change in their direction of rotation, the critical period during which the shafts stop rotating is eliminated. The likelihood of ice obstructing POLAR STAR's movement is further reduced by the continuous, high-speed rotation of her propellers, which mill ice much like the blades of a kitchen blender.

Although the controllable pitch propellers and the powerful propulsion system are able to move POLAR STAR at a continuous 3 kn through 6 ft of ice (as compared to the older icebreakers which must back away and then ram through the same thickness of ice) and enable her to ram through 21 ft of ice, there is still a possibility that POLAR STAR could be trapped in an ice field. To free herself from the ice, POLAR STAR, like her forerunners, relies on a heeling system which causes a slow, rocking motion. This side-to-side motion results from the transfer every 50 sec of 100,000 gal (400 tons) of water between three tanks on each side; the older vessels can shift only 62,500

Figure 13.--This view of the POLAR STAR's bridge shows the wide spacious layout. The width of the bridge is an indication of the ship's 83-ft width which allows it to cut a wide channel for supply ships through the polar ice. U.S. Coast Guard Photo.

gal (250 tons) of water between these tanks every 90 sec.

In spite of the sophisticated electronic equipment carried aboard POLAR STAR, safe passage through the ice is still contingent upon the human eye. From an aloft conning station 104 ft above the ice, Coast Guardsmen have a vantage point from which to spot cracks in the ice field (which eases icebreaking operations) or heavy concentrations of ice which may thwart progress. The glass-enclosed, heated conning station is entered by means of a ladder in the mast. Located within the station are engine and rudder controls and navigational devices which are similar to those found on the bridge 50 ft below (fig. 13).

Visibility across the ice fields is further extended by the use of two turbine-powered helicopters which are housed on the flight deck and in the hangar. In addition to ice reconnaissance, the helicopters are used for logistical support of the ship and for transportation of personnel and supplies to isolated research stations. Flying and maintaining the helicopters are 4 pilots and 11 aircrewmen who form the aviation detachment.

Although POLAR STAR's primary duty is icebreaking, she also functions as a research center for up to 10 scientists. In addition to a meteorological laboratory and two oceanographic laboratories, researchers have offices and a scientific library available for their use. These facilities are supplemented by two portable vans which can be connected to the water and electrical systems. Because of the vans' mobility, researchers can avoid difficulties inherent in shipping scientific equipment to a vessel and later having to set up their apparatus. Now scientific equipment can be set up in the van at the researchers' "home" facility and be ready for use when the van is placed aboard. Also facilitating research is a computer for the compilation and retrieval of data. Both scientists and Coast Guardsmen will have access to a photographic darkroom and a specially equipped room for scuba divers.

The November issue will have an article on the history of Coast Guard icebreakers.

Mariners Weather Log

NATIONAL WEATHER SERVICE MARINE DATA COLLECTION

PAST-PRESENT-FUTURE

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Silver Spring, Md.

Meteorology was probably the first area of the oceanic environment to be extensively monitored. By 1697, enough oceanic meteorological observations had been recorded that William Dampier was able to publish "A Discourse on the Winds" in which he geographically distinguished the steady ocean trades from the more variable westerlies (Richards 1906). It was not until 1853 that an international voluntary marine data acquisition network was suggested, when Lt. Matthew Fontaine Maury of the U.S. Navy Hydrographic Office at a general maritime conference in Brussels recommended "that a log book should be kept onboard vessels of war and merchant vessels, in which the observation relating to the weather should be carefully recorded" (Bates 1956). Adoption of Maury's recommendation created the International Cooperative Ship Program which today includes over 7,000 high seas ships representing 42 nations (WMO 1974). The data collected by these ships are used in the compilation of marine atlases and construction of wind and current charts of the oceans, the use of which has resulted in savings estimated in the billions of dollars by shortening voyages. Untold numbers of lives, cargoes, and ships have also been saved owing to better knowledge of the oceanic environment created by this marine observation program.

The development of the wireless telegraph by Marconi in the latter part of the 19th century brought a new era in marine data collection, and on December 3, 1905, the SS NEW YORK, at 40°N, 60°W, transmitted the first radiogram from a ship containing a weather observation to the Weather Bureau (Calvert 1923). This development enabled the Weather Bureau to improve its forecasting ability. It increased the area over which real-time marine weather observations were being made and resulted in the establishment of the Vessel Weather Service, in 1906, as a distinct part of the Weather Bureau. Today, over 2,500 synoptic weather observations per day are transmitted from ships to the various national meteorological agencies throughout the world and are shared internationally via the Global Telecommunication System (GTS) (NWS 1975).

Oceanographic data collection has not fared quite as well as marine meteorology because oceanographic data collection has and is still being conducted almost exclusively on an individual project basis (Panel on Oceanography 1966). Current knowledge of the oceanic environment has indicated that the various oceanographic disciplines are too highly interdependent to let this method of data collection continue (Commission on Marine Science, Engineering and Resources 1969). This knowledge in part was responsible for the creation of the National Oceanic and Atmospheric Administration (NOAA) which integrates the activities of the National Weather Service (NWS), National Marine Fisheries Service (NMFS), National Ocean Survey (NOS), National Environmental Satellite Service (NESS), Environmental Research Laboratories (ERL), and Environmental Data Service (EDS). The combining of these various services under NOAA has tended to focus attention to problems of the marine environment, not the least of which is the need for systematic monitoring of the oceanic environment. This need has been increased further because of the added emphasis resulting from ocean exploration and mining, dump site evaluation, pollution control, and new projects expected owing to extension of the U.S. economic zone to the 200-mi limit.

Today, there is need for a marine monitoring network that would satisfy the expanding demand of a variety of marine information users. The latest count shows 11 Federal agencies participate in some sort of oceanographic data collection program (Comptroller General 1975). Of these, NOAA components are involved in the widest range of marine data collection. NOAA has programs that sample the marine environment from the depths of the ocean to the far reaches of space. NOAA, based on its real-time functions and experience in large real-time data collection systems, would appear to be the most logical group to implement the oceanic environmental monitoring network. This network would be geared to provide real-time operational and archival data from the entire suite of physical, chemical, and biological collection devices.

There are numerous types of oceanographic sensors (tide, wave, current, salinity) on the market, but each needs a lot of maintenance to keep in operation. Automated meteorological sensors measuring visual elements (present weather, cloud cover, sea state, visibility) are either nonexistent or in a developmental stage. Even wind, temperature, and humidity sensors now in use have not been proven for unlimited use in the marine environment. Many of the sensor packages touted for marine use do not hold up in the harsh marine environment, and logistics to maintain the systems get so expensive that it becomes impractical to keep some systems in operation. For instance, the Coastal Engineering Research Center

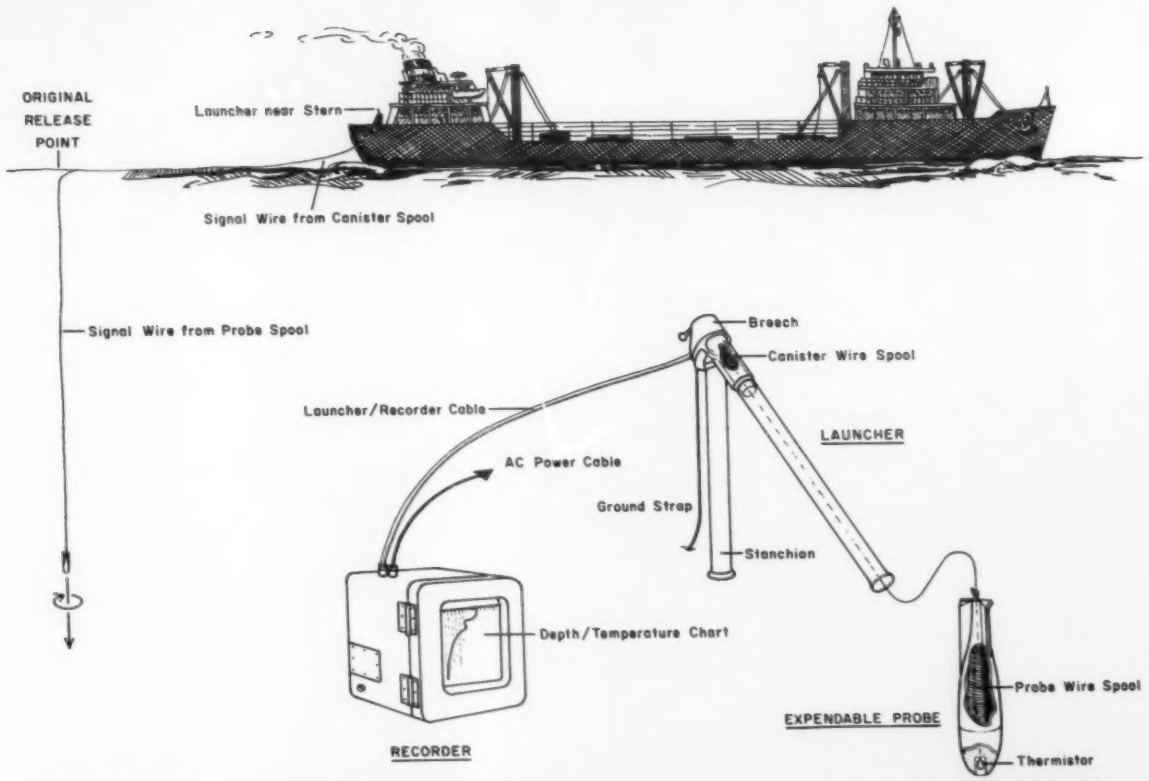

Figure 14.--The expendable bathythermograph system and its operation. Three major components of the system are the recorder, launcher, and canister containing the expendable probe and signal wire. The dual-spooling system for the signal wire permits the probe to sink vertically from its point of entry and the observation to be recorded as the ship proceeds on course.

(CERC) of the U.S. Army Corps of Engineers (COE) figure they need 200 percent in spare parts plus 1/3 man-year maintenance/unit to maintain their wave gage system at 80 percent efficiency (Peacock 1974).

CERC's estimates may sound high, but they are conservative when considering all that can happen to sensor packages installed in the hostile marine environment.

NOAA's marine data acquisition involvement includes (1) a fleet of 20 oceanographic ships, (2) 10 data buoys in various stages of development, (3) 7 satellites with varying degrees of oceanic environmental sensor capabilities, (4) Ocean Station Hotel operating for 9 mo each year, and (5) networks of (a) 120 tide gages including the Tsunami alert system, (b) 59 automated meteorological stations in the coastal zone, and (c) 200 manned Coast Guard and other volunteer coastal weather observing stations. The remainder of marine observations NOAA receives are from volunteer marine observers aboard coastal, Great Lakes, and high seas vessels. Almost all observations from the coast, near shore, and high seas are made by volunteer observers. Very few of the observers are paid by NOAA for making observations. Most of the observations made by the volunteers are meteorological in nature, but they do include sea state and water temperature aboard ships and at some coastal stations. There are a few NOAA-sponsored subsurface temperature (XBT) collection programs on several high seas merchant and fishing vessels (fig. 14).

NOAA has the start of a marine data collection network that could be added to and improved to eventually serve nearly all of the Federal and private sector needs for marine environmental information. NOAA is the principal government environmental data user. Just consider the data requirements of the National Weather Service with forecast and warning responsibilities north of the Equator for the Atlantic Ocean west of 35°W and the Pacific Ocean east of 160°E plus all U.S. coastal and near shore waters. Add a NWS oceanographic prediction service to this, and a much more ambitious data collection network than the one in existence is required. To reach its goal, the NWS plans through the budget and mutual support process to (1) purchase, install, and maintain marine environmental sensor systems to be utilized at automated or manual reporting stations, (2) support research and development of marine meteorological and oceanographic sensors, and (3) improve existing marine networks using modern technological advances in data processing and communications.

NWS (NOAA) is now asking for budgetary support to begin the nucleus of a marine network that would meet most NWS forecast and warning needs and would

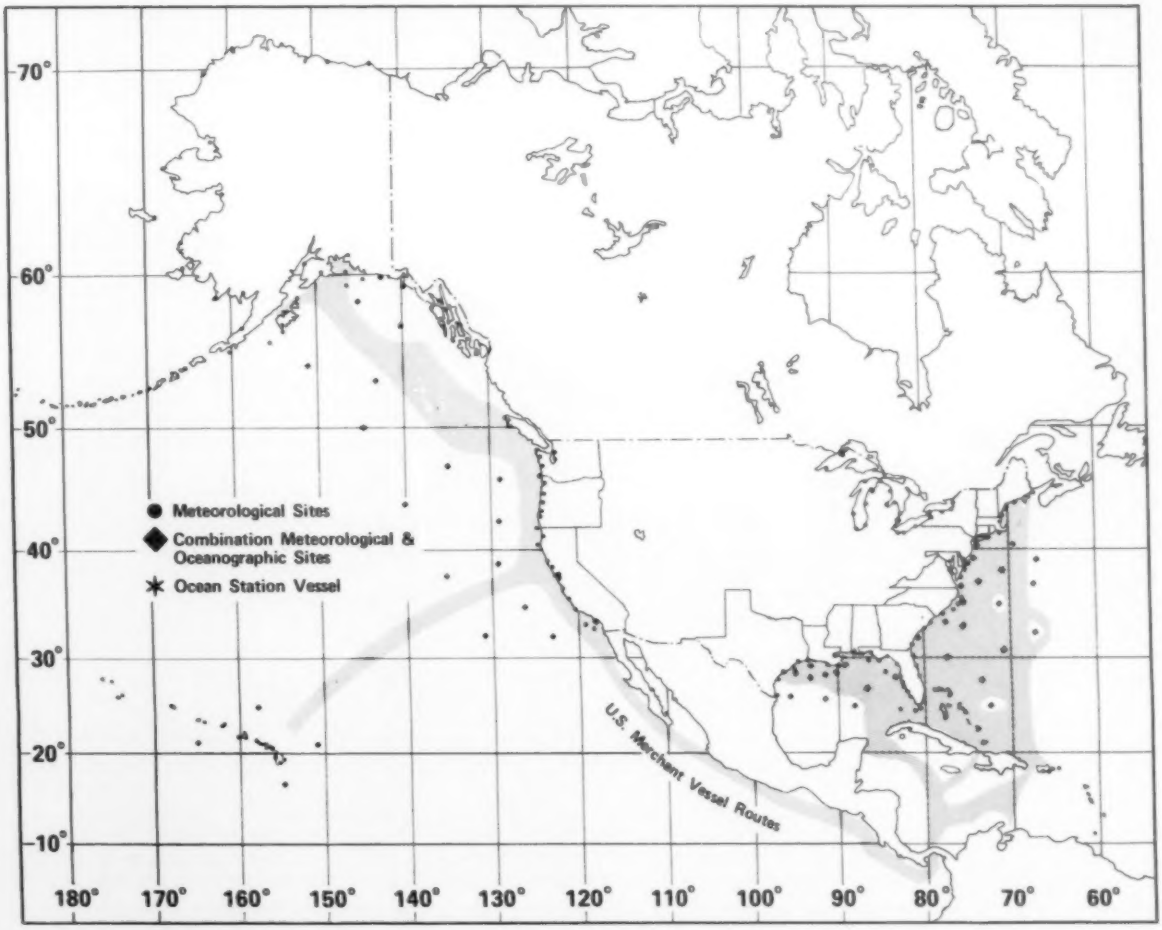

Figure 15.--Components that make up the basic marine observing network.

support a limited NWS oceanographic service program. The network would also enhance the Environmental Data Service's ability to prepare quality marine climatological atlases and to fulfill most of the increased demand for oceanic environmental data. The network would be expanded until it approached the quality of the NWS land-oriented network. It would also consider and support most Federal and private sector marine environmental data needs.

The NWS has begun to expand into marine data acquisition by establishing automated marine environmental stations along the coast and on offshore platforms. The prototype of an automated system for high seas ships is being developed, while the NOS is well along on providing an optimum sensor package for deep-ocean buoys. NOAA is also striving to establish a suite of marine sensors applicable to both manned and automatic stations.

To reduce costs, communication of all automated data would be made via satellite. The NOAA data network envisioned would consist of varied types of automated stations. The parameters measured at each site will be determined from need and would vary from windspeed only to a full parameter station including both oceanographic and meteorological sensors. The satellite communication feature of the network will be used to feed ground truth values to the various satellite sensor systems. The basic network now considered to meet most of NOAA's needs would have 150 coastal stations, 18 offshore platforms, 32 data buoys, and 100 NOAA, Coast Guard, and merchant vessels (30 of which will make XBT's) (fig. 15).

The approximate cost of the network, including 100 to 200 percent spare equipment and 2 per year maintenance visits, is about $20 million to equip and install. There would be a yearly recurring cost of $1 million to maintain the network. The recurring price for maintaining the network is high, but it should reduce radically as new advances in engineering and sensor technology become incorporated into the network.

Marine data collection systems are expensive and should be undertaken by as few of the Federal agencies as possible. Remote sampling of the ocean en-

vironment is in its infancy, so Federal agencies needing marine information must develop a consolidated effort to reduce overall costs. Many agencies and private companies involved in ocean projects conduct independent data collection projects which result in duplication of effort at high dollar and manpower costs. NOAA has had the most experience and is the principal user of marine environmental data.

Editor's Note: This paper is to be presented at the Conference on Coastal Meteorology which will be held at Virginia Beach, Va., in late September 1976.

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WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US. THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.

Hints to the Observer

SEA AND SWELL OBSERVATIONS

Wave observations are important to mariners and to forecasters, who rely on the observations in making analyses and forecasts. The wind, wave, and pressure observations from ships are the only data the forecaster has for estimating when, where, and with what heights those waves will arrive at harbor entrances and beaches. Waves can travel thousands of miles, and the wave energy encountered in midocean may later endanger mariners in a port, on the ocean, or along a coastline.

All mariners are familiar with the practical difficulties in making a "good" wave observation--it takes practice, patience, and determination. Wave observations should be transmitted as the last two code groups in the International Ship Code. Basic instructions for making wave observations can be found in Chapter 9 of Weather Service Observing Handbook No. 1.

An article by C. L. Bretschneider indicated a very close correlation between the significant wave height* and the significant wave period in wave-generating areas. Table 1 is adapted from Bretschneider's findings and is applicable to local seas (wind-generated waves that are still under the influence of local winds). The table does not apply to swells, which are waves that have moved from their generating area.

From the table, it can be seen that higher waves have longer periods. There appears to be a bias on the part of many observers toward reporting the shorter periods associated with smaller choppy waves in a complex sea, rather than the longer periods which are generally associated with the significant (higher) waves. The periods of the larger, well-formed (significant) waves should be reported. The values in the table are only a guide and are not a substitute for accurate observations.

When swells clearly predominate over locally generated seas, the waves have much greater regularity of height and period, as well as longer crests, thus simplifying accurate observations. Swells of a given height normally have a longer period than local waves of the same height.

Wave observations are important. Every effort should be made to give an accurate report, as with the remainder of the observations.

Last, but not least, FORECASTERS NEED AND APPRECIATE YOUR REPORTS. With all the advances in instrumentation and technology, your surface weather observation is the best, most accurate, and, except in isolated instances, the only data available on the world's oceans, approximately 70 percent of the Earth.

*Average height of the highest one-third of the waves.

REFERENCE

Bretschneider, Charles L., "Forecasting Relations for Wave Generation," Look Lab Quarterly, Vol. 1, No. 3, pp. 31-34, July 1970.

Table 1. --Typical sea periods for various sea heights within a sea-generating area (adapted from Bretschneider, 1970)

Significant sea height	encoded as:	Significant sea period	encoded as:
up to 6 ft	01 - 03	5 sec or less	02 - 05
7 to 10 ft	04 - 06	6 to 7 sec	06 - 07
11 to 15 ft	07 - 09	7 to 9 sec	07 - 09
16 to 20 ft	10 - 12	9 to 10 sec	09 - 10
21 to 30 ft	13 - 18	10 to 12 sec	10 - 12
31 to 40 ft	19 - 24	12 to 14 sec	12 - 14
41 to 50 ft	25 - 30	14 to 16 sec	14 - 16
51 to 60 ft	31 - 36	16 to 17 sec	16 - 17

Tips to the Radio Officer

Thomas H. Reppert
National Weather Service, NOAA
Silver Spring, Md.

HIGH SEAS WEATHER INFORMATION WEST OF 35°W

High seas weather information west of 35°W is now being keyed from Radio Station NST, Londonderry, Northern Ireland. It is simultaneously transmitted from GXH, Thurso, Scotland; NRK, Reykjavik, Iceland; AOK, Rota, Spain; NAM, Norfolk, Va.; NSS, Annapolis, Md.; NAR, Key West, Fla.; and NGR, Athens, Greece. For future planning, comments are requested on this broadcast. Be sure to include specific details such as dates, times, station copied, and so forth. Address comments to National Weather Service, Silver Spring, Md. 20910, Attn: W162.

Broadcast time (GMT)		Content
0030 to 0115	NWS	Western North Atlantic warnings and coded analysis
0500 to 0600	DMAHC	All areas Hydro
0630 to 0715	NWS	Western North Atlantic warnings and forecasts
0800 to 0900	FWC	Norfolk/Rota NORLANT/EASTLANT/MED weather
1230 to 1300	NWS	Western North Atlantic warnings and coded analysis
1700 to 1800	DMAHC	All areas Hydro
1900 to 1945	NWS	Western North Atlantic warnings and forecasts
2300 to 0000	FWC	Norfolk/Rota NORLANT/EASTLANT/MED weather

Radio Station	Frequency (kHz)	Remarks
Londonderry/NST	7504.5	
	12691	0800-1900 only
Iceland/NRK	5167	
Norfolk/NAM	16180	
	20225	1200-2400 only
Thurso/GXH	3724	1900-0800 only
Rota/AOK	5917.5	
	7705	
Greece/NGR	4623	
	13372.5	0800-1900 only
Annapolis/NSS	8090	
	12135	
Key West/NAR	5870	
	25590	1200-2400 only

CORRECTIONS TO PUBLICATION, WORLDWIDE MARINE WEATHER BROADCASTS, 1975 EDITION

Page 10--Helsinki, Finland (OFB): Delete frequency 438 kHz, insert 519 kHz.

Page 15--Buenos Aires, Argentina (LPD): Delete frequency 444.5 kHz, insert 512, 4268, 12678 kHz. Delete time 0130, insert 0118. Change footnote 2 to read "In Spanish, repeated in English."

Page 39--Tampa, Fla. (WFA): Delete frequency 157.2 MHz, replace with KUZ 385, 161.8 MHz.

Page 40--Port Isabel, Tex. (NCH): Add times 1035, 1635, 2235, and frequency 157.1 MHz.

Page 48--Add new station: Kodiak, Alaska (WBH-29). Area: Gulf of Alaska. Frequency: 4136.3 kHz. Times: 0230, 1600. Content: Warnings and forecasts.

Page 51--Guam, Marianas Islands (NRV). Area: Marianas, Carolines, and Marshall Islands and 0° to 25°N between 130°E and 180°; times: 1005, 2205; frequency: 2670 kHz A3H. Area: local waters only; times: 0730, 2230; frequency: 157.1 MHz.

Coastal water forecasts for Hawaiian Islands extend out 100 mi. Change NMO, area a, pages 18 and 50, also KBP, area a, page 51.

ACKNOWLEDGMENTS

Thanks to M. Kerner, NWS; Radio Officer Patrick Nolan; Radio Officer Ben Lane, SS HAWAII; and Radio Officer M. P. Matthews, M/S THOMAS MAERSK, for recent information relative to the Marine Weather Program.

Hurricane Alley

Dick DeAngelis
Environmental Data Service, NOAA
Washington, D. C.

During May and June one tropical cyclone developed in both the Southern Hemisphere and the North Indian Ocean. Neither intensified to hurricane strength. Both originated in May. The tracks (fig. 16) and summaries are based on information provided by the National Environmental Satellite Service, warnings from the Navy Fleet Weather Central at Guam, and from tropical analysis charts at the National Meteorological Center.

SOUTH INDIAN OCEAN - MAY AND JUNE

Tropical storm Carol developed in early May close to the artificial dividing line between the South Indian Ocean and the Australia-South Pacific regions. Carol moved on a southerly course throughout her lifetime. On the 6th she was generating gales out to about 180 mi and maximum winds of 50 kn near her center. After this peak she began to weaken and by the 9th was becoming disorganized.

NORTH INDIAN OCEAN - MAY AND JUNE

The Arabian Sea was the scene of the only activity during this period. A tropical storm developed among the Laccadive Islands in late May. The storm moved due north. Maximum winds reached 50 kn with gusts to 65 kn on June 2. The following day the storm moved ashore over the Saurashtra Peninsula.

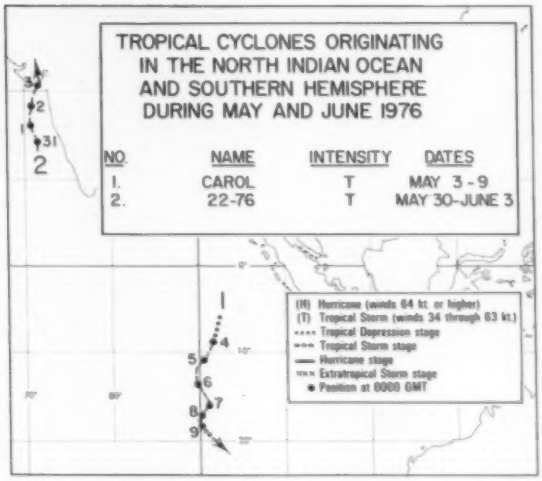

TROPICAL CYCLONES ORIGINATING
IN THE NORTH INDIAN OCEAN
AND SOUTHERN HEMISPHERE
DURING MAY AND JUNE 1976
NO. NAME INTENSITY DATES
1. CAROL T MAY 3 - 9
2. 22-76 T MAY 30-JUNE 3
(H) Hurricane (winds 64 kt. or higher)
(T) Tropical Storm (winds 34 through 63 kt.)
Tropical Depression stage
Tropical Storm stage
Hurricane stage
Extratropical Storm stage
Position at 0000 GMT

Figure 16.--Indian Ocean tropical cyclones, May and June, 1976.

TROPICAL CYCLONE PIONEER

"... and for my part I know no difference between a Hurricane among the Caribbee-Islands in the West-Indies, and a Tuffoon on the coast of China in the East-Indies, but only the name ...." This was written by William Dampier in his accounts of his world travels. To him we owe much of our early knowledge of tropical cyclones. Dampier was a 17th century English mariner and an astute observer of nature. He was also a pirate, a buccaneer, and a Navy captain. Although often described as a leader, his own accounts, as well as those of his shipmates, indicate he held no position and was but lightly esteemed. His appointment as a ship's captain was given for his literary and scientific achievements and proved a mistake. He was an incompetent commander, whose sobriety, honesty, and courage were questioned and whose highest idea of discipline was calling his subordinate officers "rogues" or "rascals."

After some early schooling and military and mer-

chant sea service, Dampier took a job in Jamaica, helping manage a plantation. His description of a storm that occurred there in 1674 is the only account on record. The following year he shipped onboard a ketch bound for the Bay of Campeche to exchange a cargo of rum and sugar for logwood. Although only a foremast hand, he kept an accurate account of the voyage, which included a detailed description of the Yucatan coast and the ignorance of the master. Homeward bound, the ship blundered into almost every shoal, reef, and island in its path. Dampier wrote, "in these rambles we got as much experience as if we had been sent out on a design." He had such a good time with the wild-living loggers that he returned to join them. The work was severe, living conditions were crude, but the pay was high and debauchery was excessive. Logging was interspersed with piracy. After a brief return to England in 1678, during which time he courted and married, Dampier returned to the Caribbean region and took up buccaneering in earnest. His exploits, which took him to Central and South America, included seizing ships and plundering coastal towns. During this period he provided detailed accounts of two Caribbean hurricanes in 1681. Dampier and about 15 of his compatriots ended up in Virginia in 1682. Joined by friends, they sailed around Cape Horn into the Pacific and then to Africa where they seized a larger vessel which they used for privateering along the fertile coast of South America. In 1686 Dampier hopped another pirate ship for the East Indies. After a 6-mo orgy in Mindanao (Philippines), the crew, including our hero, left the captain and put to sea. During their cruise to New Holland (Australia), Dampier had made up his mind to desert or escape. However, after some disagreements among the crew, he and a few of his friends were put ashore in the Nicobar Islands, where it was thought they could not escape. However, with the help of some natives they outfitted a canoe and undertook a perilous, stormy journey to Sumatra. A few of his band died, and Dampier himself was seriously ill for a time. He made it back to England in 1691, and 6 yr later he published the account of his "Voyage round the World." The book ran through four printings in 2 yr. This prompted him to bring out a second volume which included his "Discourse of Winds," a classic in marine climatology.

Dampier's fame led to his appointment to command an exploration of Australia and the surrounding lands. This voyage was a disaster. Almost upon leaving port he quarreled with his lieutenant who was then beaten and clapped in irons. His ship, the ROEBUCK, sprung a leak which eventually became uncontrollable and was finally beached. Upon his return to England, Dampier was court-martialed and found "guilty of very hard and cruel usage toward Lieutenant Fisher." He returned to the life of a privateer in command of the ST. GEORGE, sailing the South Seas. During these escapades he was charged with drunkeness, oppression, abusive language, and cowardice. Accounts of his actions were published in England before he returned. Dampier replied angrily in a pamphlet entitled "Vindication." Although proof was lacking, his reputation suffered, and shipowners would not entrust him with another command. On his last voyage Dampier was a pilot aboard the privateer DUKE which sailed, in 1708, from England around Cape Horn into the Pacific. They returned by way of the Cape of Good Hope after a profitable voyage. However, Dampier died 4 yr before the prize money was distributed.

In spite of this adventurous and turbulent life, Dampier kept accurate, detailed accounts of all he observed. His surveys and charts were excellent for that day. His descriptions of general and local weather conditions have withstood the test of time.

On the Editor's Desk

NOAA, EXXON, EXAMINE OIL CONTENT OF MEDITERRANEAN SEA

NOAA scientists and the Exxon Research and Engineering Company of Linden, N.J., have begun a joint examination of how much oil is in the Mediterranean marine environment and whether this contamination is increasing.

The project is supported by a contract from the Marine Ecosystems Analysis program, part of NOAA's Environmental Research Laboratories, which studies the relationships between human activity and the marine environment.

Personnel aboard Exxon ships will collect samples of Mediterranean Sea water which NOAA scientists subsequently will analyze for hydrocarbon levels and compare with data obtained 3 yr ago in cooperation with the U.S. Maritime Administration.

Data taken in the present study also will be compared by NOAA researchers with hydrocarbon levels in the New York Bight and Puget Sound, both sites of ecosystem analysis studies.

Information from the study should help scientists refine appraisals of how much oil is in the global sea. It is estimated, for example, that a total of some 6.7 million tons (6.1 million metric tons) or 50 million barrels of petroleum hydrocarbons enter the ocean every year from all sources, both human and natural. Of that yearly total, natural seeps contribute an estimated 0.7 million tons (0.6 million metric tons) or 4.4 million barrels, and offshore petroleum production contributes an estimated 0.09 million tons (0.08 million metric tons) or 0.6 million barrels.

ST. LAWRENCE SEAWAY NAVIGATION SEASON WILL CLOSE ON DECEMBER 18

The St. Lawrence Seaway will close to 1976 navigation on December 18. The date was announced jointly by the administrator of the St. Lawrence Seaway Development Corporation and the president of the St. Lawrence Seaway Authority, the Canadian arm of the international waterway. This year's closing date

is the same as last year, up to then the latest in the history of the facility.

According to the announcement, no inbound vessels will be accepted at St. Lambert Lock near Montreal, or outbound ships at the Iroquois Locks, after 0800 hours on December 18.

The announcement adds that the closing date of the Welland Canal, linking Lakes Erie and Ontario, will be December 30.

SEA ICE DATA - NORTH COAST OF ALASKA

Table 2 was taken from the May 1976 issue of Sealift, the magazine of the Military Sealift Command. It indicates the severity of the sea ice off the north coast of Alaska from Point Barrow to Prudhoe Bay from 1958 to 1975 in the order of severity. The table was prepared by the Fleet Weather Facility, Suitland, Md., as part of the development of their long-range sea-ice forecasting techniques.

POLAR ICE MOVEMENT AND SUBSEA PERMAFROST STUDY

The U.S. Army Corps of Engineers' Cold Regions Research and Engineering Laboratory in Hanover, N.H., has been awarded contracts by NOAA to study ice movement and subsea permafrost along the Beaufort Sea coastline adjacent to Alaska's North Slope oil fields.

This is part of an environmental study managed by NOAA's Environmental Research Laboratories for the Bureau of Land Management as a portion of its Outer Continental Shelf Environmental Assessment Program. These studies seek to determine the probable ecological impacts of oil exploration and development activities on Alaska's outer continental shelf.

Basic goals of the research, begun last summer, are to obtain detailed information on nearshore pack ice and fast ice (ice attached to the shore or sea floor) movements and to describe the subsea permafrost and its engineering characteristics along the coast of the Beaufort Sea.

The site of the ice study is Cross Island, 11 mi (19 km) off the coast in the vicinity of Prudhoe Bay, an area of possible offshore oil development.

Because sea ice dominates the surface of the Beaufort Sea for long periods each year, the ice may concentrate or restrict the movement of any spilled oil and preserve high concentrations of it for subsequent release by the ice at distant locations. Oil could also affect ice distribution by changing the amount of heat transfer through the ice.

For these reasons the Federal scientists hope to develop an understanding of the behavior of ice-oil interactions, the forces affecting the ice deformation process, and the ice movements.

Results of the research will help bridge the gap between large- and small-scale ice motions that must be understood for the design of offshore petroleum operations in the Arctic. The collected data will also

Table 2.--Severity index and sea ice data

	SEVERITY INDEX	YEAR	1 nmi *	2 nmi	3 nmi	4 nmi	5 DATE	6 DATE	7 # DAYS	8 # DAYS	9 OUTLOOK
MILDEST	1	1958	50	150	50	210	7/19	10/25	92	99	FAV
	2	1968	25	165	30	200	7/19	10/18	86	91	FAV
	3	1962	25	150	30	150	7/19	9/30	49+	68+	FAV
	4	1961	15	105	15	135	7/25	9/24	49+	62+	FAV
	5	1973	5	80	5	190	7/31	10/20	73	62	FAV
years are	6	1963	5	130	5	130	8/13	10/18	67	67	UNFAV
listed in	7	1959	20	65	20	65	7/19	10/6	42	86	FAV
reverse	8	1972	0	60	30	90	7/31	10/1	45	63	FAV
order of	9	1954	20	115	20	210	8/1	9/30	38+	61+	FAV
severity	10	1974	10	100	10	100	8/6	10/5	35	61	FAV
based on	11	1957	5	45	70	60	8/1	10/6	18	67	FAV
parameters	12	1967	15	0	30	50	7/25	10/12	UNK	68	FAV
in columns	13	1966	5	0	5	45	8/1	10/22	24	65	UNFAV
2,4,5,7&8	14	1965	0	10	0	70+	8/25	9/25	25	32	UNFAV
	15	1953	0	0	5	35	7/27	9/16	5	52+	UNFAV
	16	1971	0	0	0	30	8/23	11/1	8	71	UNFAV
	17	1960	0	0	20+	20	8/5	9/7	0	34	UNFAV
	18	1964	0	0	0	5	8/13	9/20	0	39	UNFAV
	19	1970	0	0	5	0	8/6	9/14	0	32	UNFAV
	20	1956	0	0	0	40	9/7	9/30	0	24	UNFAV
	21	1969	0	0	0	30	9/7	9/18	5	12	FAV
	22	1955	0	0	5	15	9/13	9/24	0	12	UNFAV
MOST SEVERE	23	1975	5	0	5	0	NEVER	NEVER	0	0	UNFAV

Column 1 - Distance from Point Barrow northward to ice edge on August 10. *Nautical miles.
Column 2 - Distance from Point Barrow northward to ice edge on September 15.
Column 3 - Distance from Point Barrow northward to boundary of 4/8ths ice concentration on August 10.
Column 4 - Distance from Point Barrow northward to boundary of 4/8ths ice concentration on September 15.
Column 5 - Initial date entire sea route to Prudhoe Bay less than or equal to 4/8ths ice concentration.
Column 6 - Date that combined ice concentration and thickness dictate end of prudent navigation.
Column 7 - Number of days entire sea route to Prudhoe Bay ice free.
Column 8 - Number of days entire sea route to Prudhoe Bay less than or equal to 4/8ths ice concentration.
Column 9 - Favorable or unfavorable summer.

relate to the pileup of deformed ice which may occur around future oil rigs.

To provide information useful in developing criteria for safe offshore oil exploration and recovery facilities, the Cold Regions Research and Engineering Laboratory scientists also are examining the physical and engineering characteristics of permafrost which exists beneath the ocean floor along the Beaufort Sea coast.

This study is a cooperative effort between the Corps of Engineers, the U.S. Geological Survey, and the University of Alaska. Objectives of the research are to develop an offshore permafrost map which will show the occurrence and depth of subsea permafrost in the Beaufort Sea and evaluate the hazards imposed by these conditions. The research team will also determine the engineering characteristics of subsea sediments and their relation to temperature, sediment type, ice content, and salinity.

Using the sea ice as a platform, the Federal scientists are drilling a series of holes in a line offshore from Prudhoe Bay to a depth of about 450 ft (150 m). The holes will be extensively sampled and instrumented for geothermal observations, while core samples and cuttings will yield information on shelf sediments and fossil content. The investigations will also include tide and current measurements.

UNITED STATES
DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

PUBLIC SERVICE AWARD

presented to

in recognition of service
contributing to the Public Safety
and Welfare performed for
the National Weather Service

Director, National Weather Service

Figure 17.--Public Service Award received by U.S. Coast Guard radio stations.

NWS PUBLIC SERVICE AWARDS PRESENTED TO COAST GUARD STATIONS

National Weather Service Public Service Awards (fig. 17), the highest honor the Weather Service can confer on an individual or agency, were presented to the U.S. Coast Guard in Washington, D.C., at the Radio Washington transmitter site in Alexandria, Va. Dr. George P. Cressman, Director, National Weather Service, presented the award to Captain Walter W. Kahr, Jr., USCG, Commanding Officer of the Coast Guard Washington Radio Station (NMH), in recognition of services provided by personnel of that station (fig. 18). Looking on (center) is Rear Admiral Glenn O. Thompson, USCG, Chief, Office of Operations, U.S. Coast Guard Headquarters, who accepted the following letter of appreciation from Dr. Cressman.

Commandant
U.S. Coast Guard
Washington, D.C. 20590

Dear Admiral Siler:

The Coast Guard's cooperation in the collection and dissemination of marine weather information has been called to my attention. These services have provided the National Weather Service and the marine community with a wealth of information over the years.

I understand that the credit for these services is due to the work of your people involved in telecommunications and in particular, those assigned to the following Coast Guard Communication Facilities:

Washington (NMH)	San Francisco (NMC)
Boston (NMF)	Long Beach (NMQ)
Miami (NMA)	Astoria (NMW)
New Orleans (NMG)	Adak (NOX)
San Juan (NMR)	Ketchikan (NMJ)
Portsmouth (NMN)	Kodiak (NOJ)
Honolulu (NMO)	Guam (NRV)

On behalf of the National Weather Service, I'm pleased to inform you that its Public Service Award is being presented to each of these stations.

Sincerely,

/s/
George P. Cressman
Director, National Weather Service

Figure 18.--Dr. George P. Cressman, Director, National Weather Service, presents a Public Service Award to Commanding Officer of Coast Guard Washington Radio Station (NMH), Alexandria, Va. U.S. Coast Guard Photo.

The awards are in appreciation of efforts by Coast Guard personnel to increase the number of marine weather observations obtainable from tugs, yachts, and other vessels that normally do not have radio officers to transmit weather reports.

The National Weather Service and the U.S. Coast Guard work closely together to keep marine weather information flowing into the National Meteorological Center in Camp Springs, Md. The National Meteorological Center uses the marine weather information, along with the thousands of other weather observations it receives daily from land stations, aircraft, radiosondes, radar, buoys, and satellites, to forecast the weather. To help NWS reach mariners, the Coast Guard broadcasts weather forecasts and warnings from its stations along the nation's shorelines.

DRIFTING BUOYS PROBE THE WORLD'S OCEANS

The NOAA Data Buoy Office's (NDBO) buoy program has grown extensively since the first tests conducted with the NIMBUS-6 satellite. At this time, approximately 50 severe environment drifters configured as shown in figure 19 have been deployed. Deployment areas have included the Gulf of Mexico, Atlantic Gulf Stream, Caribbean Sea, tropical Pacific, Gulf of Alaska, the southern ocean near Drake Passage, South Atlantic below Cape Town, South Africa, and the Bay of Biscay off the coast of France.

The program is designed to prove that technology and available hardware can meet the requirements of the largest international cooperative scientific project ever attempted--the First Global Atmospheric Research Program (GARP) Global Experiment (FGGE). If the test phase of the drifting buoy program is successful, as many as 350 buoys may be deployed in the southern ocean during this experiment.

Typical of the international cooperation being enjoyed by the drifting buoy programs was the recent deployment undertaken by the South African Commonwealth Scientific and Industrial Research (CSIR) organization's National Research Institute for Oceanology (NRIO), the South African Weather Bureau, the University of Cape Town, the NDBO, and the National Center for Atmospheric Research (NCAR). Eight buoys were deployed on the Greenwich meridian between latitudes 65°S and 35°S when the South African Antarctic supply ship RSA returned to Cape Town from Antarctica in mid-February. Four of these were made at NRIO in Durban, South Africa, and the other four were supplied by NDBO and NCAR. The buoys were equipped to transmit data, including atmospheric pressure, windspeed, and surface water temperature, to the satellite which also has the capability of determining the position of the buoys.

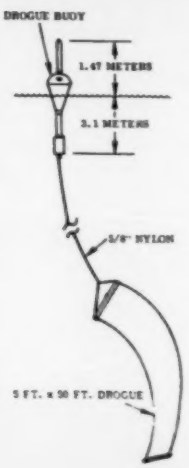


Figure 19.--Severe Environment Drifting Buoy.

One of the South African-built buoys carries an experimental package to measure wave characteristics. It was deployed in the area where storm waves which periodically batter the Southwest Cape coast are generated. If successful, it may pave way for the development of an early warning system based on buoys deployed in the area. This kind of information could be important for the protection of ocean and coastal engineering ventures in South Africa.

The information transmitted from the buoys is stored on the satellite's onboard recorder and, at appropriate times, retransmitted to a receiving ground station located in Alaska. The information is then routed to NDBO and South Africa through NASA's Goddard Space Flight Center via conventional communications channels.

Because this area of ocean is the birthplace of many of southern Africa's weather systems, the data will be of great use to meteorologists. The satellite's position-fixing capability will enable it to follow the drift of the buoys and, therefore, define oceanic current trajectories.

The most recent cooperative international venture was the Joint U.S.-French Drifting Buoy Experiment which embarked from Brest, France, on April 19, 1976. Four of NDBO's severe environment buoys were deployed from the French research vessel JEAN CHARCOT. NDBO's acting Chief Scientist participated in that deployment, and the results of the experiment will be published at a later date.

AMVER COMPULSORY FOR NORWEGIAN VESSELS

Norway is to become the world's first nation to make compulsory the membership of vessel operators in the Automated Mutual Assistance Vessel Rescue organization (AMVER), according to the Norwegian Information Service. Starting September 1, Norwegian merchant ships in foreign trade, along with oceangoing fishing, whaling, and sealing vessels, must belong to AMVER, an adjunct of the U.S. Coast Guard with headquarters in New York.

More than half of Norway's foreign trade fleet already reports voluntarily to AMVER, a position reporting system for assisting vessels in trouble.

The new regulations also impose on Norwegian shipping the obligation to report arrival and departure from port along with deviation from or delay on the planned route.

Failure to make the reports to the owner or owner representative on shore makes a vessel captain liable to prosecution.

STORM EVACUATION MAPS ISSUED FOR GULF COAST

Publication of nine storm evacuation maps along the Gulf of Mexico from New Iberia, La., to Beau-

mont, Tex., has been announced by NOAA.

Designed to facilitate evacuation of persons from endangered areas, the storm evacuation maps are prepared by NOAA's National Ocean Survey. The maps show emergency evacuation routes, areas subject to flooding from hurricanes and other storms, and elevations which might afford "safe islands" for storm evacuees.

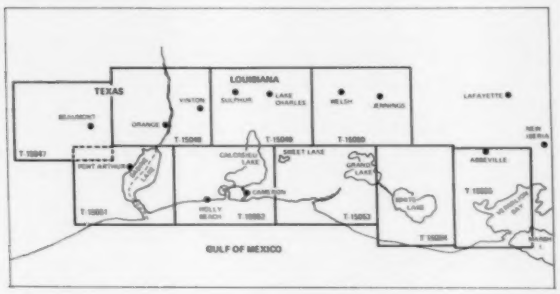


Figure 20.--New Iberia, La., to Beaumont, Tex., storm evacuation maps.

The nine maps (fig. 20) include parts of the Louisiana parishes of Iberia, Vermilion, St. Martin, Cameron, Calcasieu, Jefferson Davis, and Acadia as well as Newton, Jasper, Orange, Liberty, Hardin, and Jefferson counties in Texas. In addition, numerous communities are covered by the maps, including Beaumont, Port Arthur, and Orange, Tex., and Vinton, Sulphur, Lake Charles, Welsh, Jennings, and Abbeville, La. Numerous beaches and other points of public interest along the Gulf Coast also are covered.

Storms, particularly hurricanes, on the Atlantic coast and in the Gulf of Mexico cause extensive flooding of low-lying coastal regions. The National Weather Service maintains a close watch on the storms, predicting the height of the storm surge and issuing warnings for areas subject to flooding. The program was instituted by NOAA to fill a need for special-purpose maps to facilitate evacuation of people from endangered areas.

Storm evacuation maps include a delineation of areas subject to flooding by surges of various heights; main evacuation roads and feeder roads; low points along the roads that might be engulfed; and high spots which are likely to remain unaffected by flood waters, thus affording some degree of refuge. Ground elevations along evacuation routes are spaced on the maps at intervals not exceeding 2 mi. Population is given for all major urban and resort areas.

Areas subject to flooding are shown in increments of 5 and 10 ft by distinctive color tones separated and defined by contours. Both surfaced and unsurfaced evacuation roads are identified, along with county, state, and Federal route designations and the number of lanes for each road. The maps also depict railroads which may offer avenues of escape. Details are sufficiently clear so that the maps can be reproduced by mass circulation media, including newspapers and television.

To date, maps have been issued for six Gulf Coast areas: New Orleans, La., to Mobile, Ala.; New Orleans to the Mississippi Delta; Houma to New Iberia, La.; Galveston to Houston, Tex.; Corpus Christi, Tex.; and the Tampa Bay, Fla., area; as well as the Atlantic coast region from Charleston, S.C., to Savannah, Ga.; the Greater Tidewater area of Virginia, including Norfolk; and New York-New Jersey coastal areas, including all of Long Island.

The maps are available to the public for $2.00 each from Distribution Division (C44), National Ocean Survey, Riverdale, Md. 20840.

NOAA SCIENTISTS MODEL GULF STREAM

NOAA scientists have described the precursors of the Gulf Stream in a mathematical model that simulates currents in the Gulf of Mexico and may eventually be used to predict where those currents would carry oil spilled in the Gulf.

The model has been applied to Gulf currents by scientists at NOAA's Atlantic Oceanographic and Meteorological Laboratories (part of the Environmental Research Laboratories) in Miami, Fla., for the Interior Department's Bureau of Land Management.

It is the first in an evolving family of such models that could be used in predicting oil spill trajectories in the Gulf of Mexico, an important element in assessing the probable impact of outer continental shelf petroleum development there.

According to Robert L. Molinari, the oceanographer directing the modeling effort, the mathematical equations which compose the model make use of density data--salinity and temperature measurements taken at different ocean depths--to calculate currents.

The mathematical model is an adaptation of a larger model developed for the ocean by NOAA's Geophysical Fluid Dynamics Laboratory in Princeton, N.J. Containing such elements as wind stress, bottom topography, and other "real world" properties, the model includes more dynamical processes than are found in traditional methods of computing currents from density data and should give more accurate results. The Gulf is a smaller area, so the same basic equations as the ocean model can be used, but modified to improve spatial resolution, accommodate Gulf boundary conditions, and so forth. The modifications have been the work of David Behringer of the Miami facility, with support from the National Science Foundation.

The present model is purely diagnostic; that is, it uses a "snapshot" of density data to calculate currents. In general it tells where to expect water movements between the eastern and western Gulf and gives some new ideas on how a fluid body of this size behaves.

Data used in the model were the result of hundreds of days of research at sea, most aboard the NOAA ships RESEARCHER and VIRGINIA KEY. In addition to classical oceanographic tools, the experimenters used free-drifting buoys to define the three-dimensional movement of water in the Gulf of Mexico.

Their work took the investigators into what amounted to an intricate root system of massive, fast-flowing currents which culminate a few miles east of the Miami laboratory as the Gulf Stream.

Observations made during the Cooperative Investigation of the Caribbean and Adjacent Regions (CICAR) confirmed these roots cannot be considered separately. A current that is continuous in structure but not in nomenclature can be traced through the entire Cayman Sea-Gulf region. The westward-flowing Cayman

Current enters the Cayman Sea between Jamaica and Honduras, where surface velocities approaching 75 cm per sec (1-1/2 mi/hr) and volume transports greater than 25,000,000 m^3 per sec (about 900 million ft^3) have been measured.

Nearing the Yucatan Strait, the Cayman Current turns north to become the Yucatan Current, and surface current speeds increase significantly--threefold increases have been measured directly. Then, in the Gulf of Mexico, the Yucatan becomes the Loop Current, which drifts across the Gulf into the Straits of Florida, where major accelerations again occur as the current becomes the Florida Current, the major tributary of the Gulf Stream.

The Loop Current also dominates the present model of water movement in the Gulf; but in order for the present model to take the next step, to prediction, it will have to tap farther into this indivisible current system than it now does. There are indications that the model will have to be extended southward to predict currents in the Gulf.

BUOY LOCATIONS AND MEASUREMENT CAPABILITIES

During 1976 the NOAA Data Buoy Office (NDBO) will deploy a number of prototype operational data buoys. Some will replace existing buoys, and some will be used to establish new data buoy stations. This item will identify the buoy locations and the parameters which will be measured. The locations of the data buoys already operational and the new stations to be established during the remainder of 1976 are shown in figure 21. The dates shown indicate the deployment schedule for new buoys.

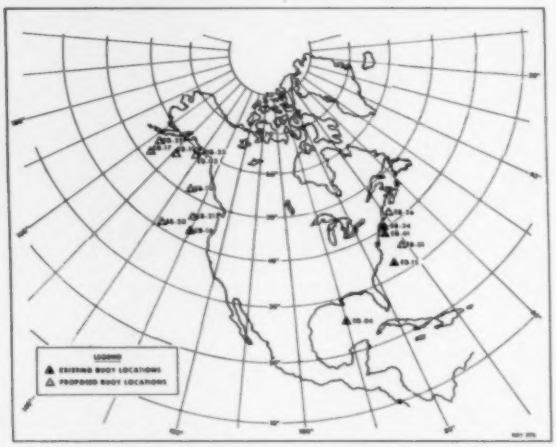


Figure 21.--NDBO buoy locations for 1976.

This prototype operational data buoy program provides proven hardware to meet the established needs of data users on a reimbursable basis. The users of the data include the National Weather Service and other operational groups, industry (especially offshore), and the scientific community. Support for major national programs, such as the marine leg of the Trans-Alaskan Pipeline System, has had an influence on the buoy stations and measurement capabilities.

In order to insure the proper performance of operational data buoy systems and to assure users of acceptable data quality, NDBO maintains an ongoing systems analysis data quality program. Periodically, statements of data quality are published.

The buoys listed in table 3 include deep-ocean moored buoys and buoys moored in continental shelf areas. As indicated by the locations, these buoys will be moored in the western Atlantic, the Gulf of Mexico, the eastern Pacific, and the Gulf of Alaska. The indications of measurement capabilities are self-explanatory. The number of wave spectral estimates indicates the number of frequency bands included in the wave spectral data.

The data from all NDBO buoys are collected via telemetry at shore collection stations and, after processing into the proper format, are forwarded in real time to operational users via the standard teletype weather data networks. At the present time, meteorological data are coded in the form of ships' weather reports; subsurface temperature data are in the Bathy format; and a special wave data message is sent containing values of spectral density as a function of frequency. For use in scientific research, carefully edited data are sent to NOAA's Environmental Data Service (EDS) for archiving; EDS distributes these data to users on request.

The NDBO has initiated a request for funds to develop a fast-response capability for deploying new buoys to meet users' data needs in a timely manner on a reimbursable basis. It is anticipated that beyond 1976 there will be additional buoys deployed to meet established requirements, if such funds become available.

Table 3.--NDBO moored buoys and measurement capabilities

Buoy Station Designation	Location	Wind Vel. Air Pres. and Temp.	Wave Spectral Estimates	Sea Surface Temp.	Sub.* Surface Temp.
EB01	35°N, 72°W	X	12	X	X
EB03	58.5°N, 141°W	X	40	X	
EB04	26°N, 90°W	X**	90	X	
EB15	32.3°N, 75.3°W	X	12	X	X
EB16	42.5°N, 130°W	X	12	X	X
EB17	52°N, 156°W	X	12	X	X
EB18	56°N, 148°W	X	12	X	X
EB19	51°N, 136°W	X	12	X	X
EB20	41°N, 138°W	X	12	X	X
EB21	46°N, 131°W	X	12	X	X
EB33	59.3°N, 140.3°W	X	Exp.	X	
EB34	40°N, 73°W	X		X	
EB35	55.3°N, 157°W	X	Exp.	X	
EB36	Georges Bank	X		X	
EB41	38.7°N, 73.6°W	X	12	X	
EB44	26°N, 86°W	X	12	X	
EB71	26°N, 93.5°W	X	12	X	

* Subsurface thermistors located at 10, 20, 50, 100, 200 and 300 m.
** Also measures dewpoint temperature.

SATELLITE FOR SHIP-TO-SHORE COMMUNICATIONS

The MARISAT II Marine Communications Satellite was placed in a stationary orbit 22,300 mi above the Pacific Ocean on June 11. The satellite will work in conjunction with a sister satellite over the Atlantic Ocean. The satellites are able to transmit signals between ships and ground stations in a 120 million square mile area. Ground stations are located in Southbury, Conn., and Santa Paula, Calif., and are linked to a control center in Washington, D.C.

The U.S. Navy will use 75 percent of the network's capacity, and the remainder will be used by commer-

cial shipping. Many types of ships have installed the necessary equipment to transmit and receive the signals. The messages transmitted and received through the satellite are not affected by adverse weather conditions, signal fading, and so forth that plague the older radio communications.

SURVEY OF GULF STREAM

Spacecraft, aircraft, and watercraft teamed up during early June in an experiment to observe the Gulf Stream using remote sensing techniques about 580 km (300 mi) east of NASA's Wallops Flight Center, Wallops Island, Va.

The objective was to test the ability of various remote sensors, including active and passive microwave radar, to measure the boundary and magnitude of the Gulf Stream from space.

The satellite remote sensing techniques tested in the experiment used infrared signatures to identify the Gulf Stream boundary from space photographs. Also, a precision altimeter on the NASA Geodynamic Experimental Ocean Satellite 3 (GOES-3) is capable of measuring surface deviations in the ocean within 20 cm (8 in), and from these measurements the velocity of the current can be calculated.

In addition to the GOES measurements, the NOAA-4 weather satellite was used. A WFC-54 research aircraft from Wallops made three flights and carried instruments to measure the current by observing wave interactions. Instruments were provided by Wallops Flight Center, NASA's Langley Research Center, Hampton, Va., and the Naval Research Laboratory, Washington, D. C.

Surface measurements were made by the research vessel ADVANCE II from the Cape Fear Technical Institute, Wilmington, N.C., and manned by ocean scientists from North Carolina State University at Raleigh.

Remote sensing techniques, such as those tested in the experiment, promise to provide global-scale synoptic measurements in near real time. This is not possible through use of the traditional methods which require closely spaced ship stations or buoys to obtain the necessary measurements. Because of the time and space requirements of these methods, they are inadequate for studying fast changing or large-scale phenomena.

Scientists are interested in a better understanding of the Gulf Stream since it carries a tremendous amount of heat energy which influences the global balance of energy in the atmosphere and the ocean, and since it carries nutrients that are important for fishing. This balance affects weather and climate as well as coastal water movement.

LETTERS TO THE EDITOR

USCGC EVERGREEN ENCOUNTERS SEVERE STORM

The following was extracted from a Cruise Report of the USCGC EVERGREEN covering the period January-February 1976. The EVERGREEN was gathering data on the Gulf Stream and the South Atlantic Bight off the U.S. eastern seaboard. The report was forwarded to the Mariners Weather Log because of the severe weather encountered. The EVERGREEN (fig. 22 departed New London, Conn., January 20 and obtained the oceanographic data for the first four stations, beginning with Station 17, on Standard Section A-5, which extends from approximately 42.4°N, 65.9°W, to 37.7°N, 61.8°W. During this time the winds shifted from westerly to easterly.

"During the night of January 21 the barometer fell nearly an inch (33.8 mb), and the winds shifted to the west and increased to 40 kn. On the morning of January 22 Station 13 (41.6°N, 66.4°W) was attempted, but due to severe rolling, the STD (Salinity/Temperature/Depth) fish came out of the water and struck the ship, disabling the instrument and breaking three thermometers and a rosette sampling bottle. The instrument was brought aboard and reset with new thermometers, and the cast was accomplished by omitting the surface water sample.

"The winds continued strong and steady from the west, and the seas continued to build on January 22. Station 12 was omitted, and EVERGREEN proceeded to Station 11 in hopes the seas would moderate in deeper water. The EVERGREEN was put into position for a cast at Station 11, but the seas were such that

Figure 22.--The 180-ft Coast Guard oceanographic vessel EVERGREEN leaves the Coast Guard Yard, Curtis Bay, Md., with a $2 million face lifting that includes a new superstructure and a new bow thruster for enabling greater maneuverability. She carries an array of sophisticated equipment for carrying out her oceanographic duties in conjunction with the research work of the Coast Guard Oceanographic Unit, Wash., D.C. U.S. Coast Guard Photo.

the STD could not be put over safely. The EVERGREEN then proceeded to Station 10 (40.8°N, 65.5°W), but by this time she could not be put into position for the cast without the danger of pooping in steep seas. The EVERGREEN hove to at Station 10 to ride out the storm.

"Overnight January 22-23, one-half of an inch of ice built up on parts of the superstructure and all rigging, and for 4 hr of the morning there were no communications because of icing. Also during the night, the port whip antenna was bent backwards by the wind and sheared off the cups of the anemometer. With reports of another deeper storm behind the present one, all hope of completing Section A-5 was abandoned, and the EVERGREEN headed south to evade the weather. At noon, after recording a 60-degree roll in the trough, EVERGREEN hove to until the evening, and then put the seas on the quarter and headed southeastward."

Replacement parts were obtained at Bermuda, and on the morning of January 29 the EVERGREEN departed for Section A-6 (31.9°N, 70.1°W to 35.2°N, 75.2°W).

"On January 30 Station 1 of Standard Section A-6 was occupied in good weather, and for most of the section the work went on uneventfully. But on February 1, near Cape Hatteras, the wind freshened to 40 to 45 kn and seas built up to 12 to 15 ft. The final several stations were occupied with some difficulty. Stations 12 (34.9°N, 74.8°W) and 13 (35.1°N, 75.1°W) were taken without water sample bottles because of steady 50- to 60-kn winds. For these casts EVERGREEN was held stern to the wind, backing two-thirds on both engines continuously to hold position. During these casts, the ratio of wire out to depth attained was between 3 to 1 and 4 to 1. During the recovery half of Station 13 that night, the winds were a steady 70 kn. The final station (14) in shallow water on Diamond Shoals (35.2°N, 75.2°W) was not attempted.

"The EVERGREEN then began to head south. However, the winds continued steady at 50 to 60 kn and the combination with the Gulf Stream made slow going. At 0600 Diamond Shoals Light Station called and advised that they were not evacuated and asked us to stand by until the weather moderated. All night on February 1 EVERGREEN stood off Hatteras steaming nearly full speed on both engines to the southwest and made 1 kn backwards.

"In the morning of February 2 the winds shifted to the west providing a lee from the Cape for Diamond Shoals Light Station and a trough for EVERGREEN's southward trip to Standard Section A-7. Section A-7 was begun on the night of February 3 and completed without incident in good weather."

COAST GUARD HELICOPTER RESCUE

I wish to thank Commander P. A. Joseph of the USCGC VALIANT for the following letter and correct information on the identity of the helicopter that rescued the Captain of the OCEAN EXPRESS. I agree most heartily with the second paragraph of the Commander's letter.

Editor
Mariners Weather Log
National Oceanic and Atmospheric Administration
Environmental Data Service
Washington, D. C. 20235

Dear Mr. Wilson,

I would like to correct a small error appearing in your July 1976 edition concerning the sinking of the oil rig OCEAN EXPRESS on 15 April 1976. Although the aircraft carrier LEXINGTON did an outstanding job while on scene, it was not one of her helicopters that rescued the Captain seconds before capsizing; but rather a Coast Guard helicopter from Coast Guard Air Station, Corpus Christi, Texas.

As the eventual on-scene commander, I am told it was a marvelous piece of airmanship, and I believe the record should reflect that. All too often the Coast Guard carries out its various missions with little or no accolades. We do this because we are professional seaman and airman who derive a great deal of pride in our accomplishments. Nevertheless, I would be remiss if I did not stand up for my own service in this particular case.

The officers on board VALIANT enjoy reading and discussing your most professional magazine and look forward to future issues.

Very respectfully,

/s/
P. A. JOSEPH
Commander, USCG
Commanding Officer
USCGC VALIANT (WMEC 621)

MARINE WEATHER REVIEW

The SMOOTH LOG (complete with cyclone tracks [figs. 24-27], climatological data from U.S. Ocean Station and Buoys [tables 4 and 5], and gale and wave tables 6 and 7), is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

Smooth Log, North Atlantic Weather

March and April 1976

SMOOTH LOG, MARCH 1976--The storm paths along the Great Lakes-St. Lawrence River trade route were near normal. Those cyclones that formed off the U.S. East Coast formed farther east than usual, moved northeastward, and then turned northward toward Iceland near midocean. The storms moving out of the Gulf of St. Lawrence curved toward Kap Farvel and the Denmark Strait. During the second week of the month, one storm managed to track from South Carolina to France. There were two significant cyclones over the Mediterranean Sea.

The overall pressure pattern was near normal, except that a sublow of the Icelandic Low normally near Nordkapp was missing. The major pressure centers were more intense and slightly misplaced. The Icelandic Low was 987 mb and centered near 62°N, 35°W, versus 1005 mb near 58°N, 40°W, according to climatology. The Azores High was 1027 mb near 32°N, 40°W, versus 1020 mb near 26°N, 36°W. A high-pressure center over Germany was 6 mb higher than normal at 1022 mb.

The pressure was above normal over the ocean south of 50°N from the eastern United States to Europe where the zero deviation line turned northward to Spitzbergen and then to eastern Siberia. A large positive 11-mb anomaly covered the central North Atlantic from 50° to 15°N. Another large positive 18-mb anomaly was centered east of the Ural Mountains. There was a 7-mb subcenter over Denmark. The significant negative anomaly was 18 mb near 63°N, 33°W, reflecting the Icelandic Low.

The major difference in the 700-mb upper-air pattern was a shifting of the primary and a secondary LOW. The primary center of circulation normally over the Arctic Ocean near the U.S.S.R. was shifted to northern Baffin Island where a subcenter is normally located. The subcenter then moved southeastward near the surface Icelandic Low. This resulted in the movement of the major trough from off the U.S. East Coast to the central ocean.

Extratropical Cyclones--The first major marine storm in the North Atlantic this month originated in the Midwest on the 4th. It tracked over the Great Lakes on the 5th, and the PHILIP R. CLARKE on Lake Superior measured 54-kn winds and 10-ft seas with the visibility less than 50 yd in heavy snow. At 1200 on the 6th, the 980-mb storm was over the Strait of Belle Isle. Gales were blowing off the New England Coast. On the 7th, a second LOW developed in the circulation off Hopedale. Kap Farvel reported 40-kn winds. At 0000 on the 8th, they had increased to 55 kn. The second LOW was developing into the primary circulation center at 965 mb.

Very few ships were reporting in the area of the storm. At 1200 on the 9th, Ocean Weather Station Lima measured 40-kn winds and 16-ft waves. The second LOW remained essentially stationary over the Labrador Sea, but it started moving eastward late on the 9th. At 1200 on the 10th, the HUDSON, at 55°N, 51°W, was bounced by 55-kn winds and seas to 21 ft. Late on the 10th, the 963-mb LOW turned toward the southeast coast of Greenland. A coastal station near 67.5°N reported 55-kn winds off the sea. The storm turned southward along the coast and dissipated on the 12th.

The 11th was a good day for starting storms. This one started as a wave on a cold front southeast of Newfoundland. The KAI was south of the wave with 45-kn winds. The wave was racing along under strong zonal flow. The NEW ENGLAND HUNTER was treated to 45-kn gales as the storm raced by to the north. The ATLANTIC SONG finished much closer to the 998-mb center with 40-kn winds.

The center was nearing the Irish Coast on the 12th. OWS Romeo measured 40-kn winds and 26-ft seas. It was not until the storm was near the Irish Coast that it deepened and increased its circulation. At 1200 on the 12th, the LOW was 964 mb near Cork. Ocean Weather Station Romeo now had 45-kn winds and 39-ft seas. The LAKE ONTARIO (48.1°N, 13.4°W) suffered 50-kn winds. On the 13th, a Soviet ship off Havre had 45-kn winds and 20-ft seas. The LOW crossed the coast of France on the 13th.

During this storm the 250,000-ton OLYMPIC BRAVERY, which went aground on January 24, broke in two. The tanker was aground on the rocks at Us-

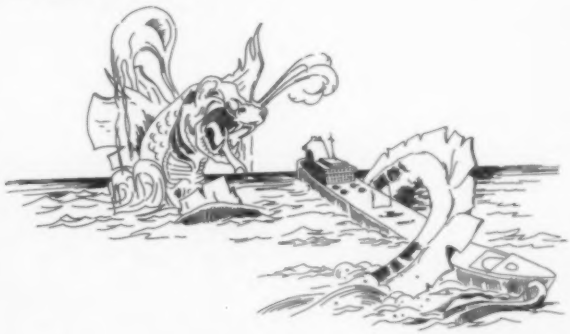
hant Island. All efforts to free the ship had been unsuccessful.

This was one of the LOWs that developed off the U.S. East Coast. It formed as a wave on the same cold front as the previous storm, on the 11th, and moved northward. By 1200 on the 12th, it was 982 mb near 45°N, 53°W. The drilling rig VGBZ, south of Sable Island, measured 60-kn winds, but the waves had not built beyond 10 ft. The HECTOR, more south of the center, near 41°N, 58°W, was sailing into 50-kn winds and waves to 20 ft. Even farther south, the CAP SAN ANTONIO (38°N, 55°W) was cruising into 40-kn winds, but the seas were 26 ft.

The 974-mb LOW was near 48°N, 46°W, at 0000 on the 13th. A SHIP east of Halifax logged 55-kn winds. The FRITHJOF (51°N, 50°W) and the PHILOSOPHER (42°N, 54°W) fought 50-kn winds with the latter having 26-ft waves. Twelve hours later, the 960-mb LOW was tightly wound near 53°N, 37°W. The 749-ton Canadian patrol vessel CAPE FREELS sank about 110 mi southeast of St. John's while in tow after a fire broke out, and the crew abandoned the ship in stormy seas. The crew was rescued. The CAST BEAVER, near 44.5°N, 45°W, had 55-kn winds and 30-ft seas and swells on her port side. The LOW reached its minimum pressure of 956 mb at 0000 on the 14th. The CAROLA REITH caught the brunt of it with 65-kn winds near 48.5°N, 33°W. The seas were 25 ft, and the swells were 46 ft. To the south, at 45°N, 33°W, the TSUGARU MARU had lighter, 45-kn winds and 33-ft swells. As the CAROLA REITH moved west for the next 12 hr, the winds decreased to 45 kn and the waves to 31 ft. Ocean Weather Station Charlie reported 23-ft waves, and Romeo had 30 ft. As the LOW passed Lima, it was weakening rapidly, and on the 15th it was gone.

This LOW can be traced back to the 5th in the mid-North Pacific. It crossed the coast of British Columbia on the 10th and the Great Lakes on the 13th. The circulation was diffuse as it crossed the Rocky Mountains, but it consolidated over the Great Plains into a large 992-mb storm. Storm warnings were issued for Lakes Superior, Erie, and Michigan for winds to 50 kn. On Lake Superior, 12-ft waves pounded the shore. On Lake Michigan, waves up to 10 ft flooded low areas and eroded the eastern shore. The storm did not deepen significantly until it moved over the open water. At 1200 on the 14th, it was 970 mb over Notre Dame Bay. The EXPORT AMBASSADOR at 37.5°N, 63.4°W, was tossed by 55-kn winds. The AQUADILLA, off Cape Hatteras, had 45-kn winds and 25-ft westerly swells. The SEALAND MARKET, at 38.2°N, 59.2°W, was pounded by 58-kn winds and swells of 38 ft. Ahead of the cold front, the MUENCHEN, near 42°N, 53°W, found 40-kn gales with 16-ft seas and 33-ft swells. The MARIE LEONHARDT at the cold front (40.5°N, 58°W) had 30-kn gales, 20-ft seas, and 26-ft swells. At 0000 on the 15th, the 960-mb LOW was near 53°N, 45°W, and the DART AMERICA was treated to 45 kn.

Later on the 15th, the LOW turned northward at 952 mb, and at 1200 Ocean Weather Station Charlie measured 60-kn winds with 30-ft seas. This was the deepest pressure the LOW attained. At 1800 the BERGJOT (56°N, 29.3°W) measured 55-kn winds and seas of 33 ft. Headed southwestward, she measured only 40 kn 6 hr later but reported 26-ft seas and 33-ft swells. At that time, a weather station on the ice cap of Greenland reported 55-kn winds with -14°C. The LOW was pounding the fjords of Greenland, at 1200, and the circulation was rapidly contracting, but the ANNA WESCH reported 40-kn winds, 16-ft seas, and 41-ft swells near 56.5°N, 32°W. Early on the 17th, the storm was a small, tightly wound center on the coast of Greenland, and it dissipated completely by the 18th.



Monster of the Month--This storm moved out of New Mexico as a frontal wave. It did not develop until late on the 16th as it approached the U.S. East Coast. By 1200 on the 17th, it was 962 mb near Yarmouth, Nova Scotia. On the afternoon of the 16th, storm warnings were issued for the New England Coast with hurricane-force winds in the Narragansett Bay area. Up to 14 in of new snow accumulated in some areas of Maine, with 20 in in northern Maine. Boon Island, along the coast of Maine, reported gusts to 75 mi/h. Ships off the east coast were observing 40- to 50-kn winds with the highest being measured as 52 kn by the BIBB near 42.2°N, 65.2°W. Seas and swells of over 30 ft were reported by four ships with the highest of 35 ft by the BALTIMORE TRADER near 37.4°N, 72.6°W.

At 0000 on the 18th, the 957-mb LOW was near Corner Brook, Newfoundland. Four ships reported 40-kn winds from Cape Cod northward. St. Pierre measured 60-kn winds. A ship at 51°N, 50°W, reported 60-kn winds just prior to passage of the occlusion. The ATLANTIC CHAMPAGNE, at 40°N, 51°W, and east of the cold front, was tossed by 20-ft seas and 28-ft swells. At 0000 on the 19th, the center was approaching Kap Farvel with a pressure of 952 mb. Ocean Weather Station Charlie measured 50-kn winds and 26-ft seas. Waves were forming on the front south of the center and moving northeastward around the perimeter. Forty knots was the strongest wind on the chart, but the ANNA WESCH reported 33-ft swells near 50°N, 42°W.

As the storm moved across the southern tip of Greenland, the LOW split, and a center moved northward along each coast. The primary center stalled near 63°N until dissipating on the 22d. On the 20th, one of the frontal waves developed into full-blown cyclone. At 1200, its central pressure was 952 mb at 56°N, 24°W. The MAMMOTH PINE, 160 mi south of the center, was blasted by 70-kn winds and seas to 23 ft. Another ship much farther south had 45-kn winds, 16-ft seas, and 26-ft swells. OWS Lima

measured 40-kn, at 0000 on the 21st, with 20-ft seas and monstrous 39-ft swells.

This center was rapidly moving northward treating Iceland to gales as high as 45 kn as it passed along the western coast to dissipate on the 22d.

On the 1200 chart of the 21st, another wave had formed on the front over the Bay of Biscay. Ocean Weather Station Romeo reported 30-kn winds from the north and 20-ft seas. By 0000 on the 22d, the 1000-mb LOW was over the Brest Peninsula. The 4,796-ton Liberian SCOL PROMINENT developed a leak due to shifting cargo while off Bordeaux, France. The 11,859-ton REA sustained hull damage while berthed at La Palisse, France, due to strong winds. The LOW then moved across Europe.

A complex frontal system was moving across the eastern United States and Canada on the 21st and 22d. The front was associated with a very sharp trough without a well-defined LOW. On the 21st, two frontal systems were approaching the East Coast. The first front moved over Baltimore's Dundalk Marine Terminal about 2000. A wind estimated at 78 kn suddenly hit the waterfront and two container cranes were wrecked and fell into the water; two others were damaged. Two workers were killed. Cargo sheds, containers and vehicles were also damaged. The falling cranes damaged the superstructures of the AMERICAN LEGION and the ALBERT MAERSK. On the 1200 chart of the 22d, a small LOW had formed near Belle Isle, Labrador. It raced northeastward past Kap Farvel by 0000 on the 23d. At 1200, the 950-mb LOW was near 65°N, 36°W. The BAMSA DAN, at 60°N, 28°W, had 45-kn gales and 16-ft waves. At 1200 on the 24th, the BAMSA DAN logged 50-kn winds with the seas still 16 ft. The ice cap station had been logging 40- to 50-kn winds for 48 hr.

Twelve hours later, at 0000 on the 25th, the ship, still in the same vicinity, logged 50 kn and 30-ft swells. By 1200, the high swells had moved to the vicinity of OWS Lima which measured 36-ft swells with 45-kn winds. The LOW was moving through the Denmark Strait on the 26th at 968 mb. Back in the vicinity of 60°N, 33°W, a ship, probably the BAMSA DAN, radioed 50-kn winds and 33-ft seas. Lima now had 21-ft waves. The high waves of about 20 ft now extended at least from Charlie to Lima. At 1200 on the 27th, another low center formed south of the Denmark Strait tightening the gradient. Lima again measured 50-kn winds and 30-ft seas. As both LOWs moved northeastward, only the two Ocean Weather Stations were reporting that far north, at 0000 on the 28th. Lima continued to have 45-kn gales and 33-ft seas. The LOW finally moved out of the area of primary interest on the 28th.

Casualties--The American-registered 15,200-ton EL TAINO was blown against a bank due to high winds while making fast to mooring buoys at Port Said on the 7th. The 6,178-ton Greek EVGENIA I ran aground on a reef in the Red Sea on February 11 and then was beached. On March 15, the vessel shifted during high winds and developed a 15 degree list. The Yugoslavian bulkcarrier SKRADIN (12,275 tons) arrived at Baie Comeau, Quebec, with ice damage. The 16,450-ton REGAL SWORD sustained ice damage to propeller blade tips on the 15th. Temporary repairs were made at Halifax. The Liberian-registered 39,949-ton ANCIENT GIANT grounded in fog off the entrance to Venice on the 16th. The 805-ton FARAG grounded off Cape Andreas, Cyprus, after diverting to Cyprus owing to heavy weather. The crew was rescued by RAF helicopter.

SMOOTH LOG, APRIL 1976--This was a light month for storms across the Atlantic--comparable to a summer month. The storm centers were concentrated northwest of a line from Cape Race to eastern Iceland. There were fewer storms that moved off the U.S. East Coast, in fact only two. There were also fewer storms that formed or tracked over the water off the coast. The primary track was from Nova Scotia to the Denmark Strait and into the Norwegian Sea.

There were major differences in location of the mean monthly sea-level pressure centers. The Icelandic Low is normally 1008 mb east of Kap Farvel. This month it was 1007 mb near 55°N, 48°W. The 1025-mb Azores High was centered near 36°N, 32°W, versus the climatological position of 31°N, 33°W, at 1021 mb. A ridge stretched northeastward from the primary center with another 1024-mb center near 50°N, 15°W.

The principal anomaly center was a plus 10-mb center near 52°N, 16°W. There were three negative 3-mb centers--over the Davis Strait, near 54°N, 50°W, and over southern Nova Scotia. The Mississippi River Valley and Great Lakes Basin areas were included in a positive 3-mb anomaly area.

The upper-air flow at 700 mb was more meridional than the usual latitudinal. The trough off the U.S. East Coast was more pronounced, and there was a sharp ridge off the European Coast. There was a large positive height anomaly east of Ireland and another centered north of Lake Winnipeg. The area from Baffin Bay to the Barents Sea was covered by negative values.

Extratropical Cyclones--This storm actually had its origin in March but was of little consequence until April. It started as a small wave on a front over Cape Sable. High pressure from Canada pushed eastward north of the LOW resulting in its moving southeastward. At 0000 on April 1, the large 999-mb system was near 32°N, 56°W. The winds were in the breeze category. On the 2d, the HIGH was squeezing between this LOW and another over Iceland, tightening the gradient in the northeast quadrant. At 1200, the EISFLETH was near 39°N, 48°W, and surprised by 50-kn winds with heavy drizzle. The seas were 23 ft and the swells 26 ft. The SHOZEN MARU, at 34°N, 44°W, had rain, 35-kn winds, obscured vision, and 13-ft waves. The frontal systems with this LOW had dissipated into only troughs.

At 0000 on the 3d, the 1002-mb LOW was at 31°N, 49°W. The ATLANTIC CARRIER (35°N, 40°W) and another ship (37°N, 45°W) both radioed reports of 40-kn winds. The seas and swells were running 16 to 20 ft. On the 4th, the LOW was moving eastward at a much faster pace and filling. It was identifiable until the 7th.

This storm formed over Florida, on the 8th, as a frontal wave. What else? At 0000 on the 9th, the 1000-mb LOW was near 31°N, 74°W, and the BRAZOS was near 29°N, 81°W, with 30-kn gales. EB15 was reporting 35-kn gales north of the center. At 1200, the MORMACVEGA (29°N, 80°W) reported 40-kn gales and 13-ft seas and swells. The storm was racing along the Gulf Stream and deepening. At 1800, the MEADOWBROOK (28.4°N, 74.4°W) found northerly 60-kn winds and 16-ft seas. On the 10th at 0000, the 984-mb center was at 38°N, 66°W, and Ocean Weather Station Hotel measured 60-kn winds with 20-ft seas. On the other side of the center another ship reported 35-kn gales and 20-ft seas.

The 8,348-ton Singapore-registered freighter SEA TRADER sank in latitude 33.2°N, 62.75°W, after heavy seas broke open a cargo hold. The 29 crew members were rescued by the 7,214-ton Greek freighter ARISTOKLEIDIS and landed at Bermuda.

At 1200 on the 10th, the USCGC RELIANCE, at 40°N, 68°W, was tossed by 45-kn winds, as was OWS Hotel with 23-ft seas. At 0600 on the 11th, the ELIZABETHPORT, at 40.5°N, 62.1°W, was headed into 50-kn winds and 25-ft seas and swells. By 1200, the 982-mb center was over southwestern Newfoundland. The drilling rig VGBZ measured 50-kn winds with swells to 13 ft. Near 45°N, 59°W, the ATLANTICA MARSEILLE was hammered by 40-kn winds and 13-ft waves.

The LOW continued toward Kap Farvel leaving behind a small circulation over Nova Scotia. A ship reported a thunderstorm ahead of the front. The storm center passed over Kap Farvel about 0800 on the 12th. Ocean Weather Station Charlie measured 40-kn winds and 20-ft seas while Lima measured 50-kn winds. Twelve hours later, Lima had 40-kn winds and 26-ft seas, as Charlie reported 20-ft seas. The storm continued across Iceland and disappeared over the Norwegian Sea.

A LOW formed over the Strait of Belle Isle in the trough of a LOW that preceded it and was approaching the Davis Strait. It meandered southeastward very slowly at about the same pressure. On the 0000 chart of the 16th, another LOW formed on the front associated with the storm near 47°N, 49°W. By 1200, the two had combined into a 1004-mb LOW at 52°N, 46°W.

The ATLANTIC CONVEYOR and a trough behind the front converged at 50°N, 39°W, with 50-kn winds and 13-ft waves. To the south, the C. P. VOYAGEUR found 40-kn winds and 20-ft waves with the same trough near 46°N, 40°W. At 1200 on the 17th, OWS Charlie contended with 30-kn winds and 20-ft seas. A ship north of Trinity Bay logged 45-kn gales.

On the 18th, the LOW deepened rapidly, dropping 14 mb in 12 hr to 984 mb near 57°N, 36°W. The wind reports remained in the minimal gale category. The POST CHARGER, far to the south, near 45°N, 37°W, had 40-kn gales and 15-ft seas. At 1200 on the 20th, a ship, near 46°N, 22°W, had 40-kn with seas and swells of 26 ft. On the 20th, the LOW died on the Greenland coast.

Monster of the Month--The predominant pressure center associated with this storm and the resulting tragedy was a high-pressure center off the Carolinas. The HIGH was over the Arctic Ocean, centered near the North Pole on the 6th. It moved southward across Canada and was over the central United States on the 12th. On the 14th, it was centered off the Carolina coast south of Cape Hatteras where it became relatively stationary at 1025 mb. Its western circulation extended to the Mexican coast. For several days a stationary front had paralleled the eastern slopes of the Rocky Mountains and into central Mexico, with a LOW near the Colorado-Kansas border.

On the 15th at 1200, the HIGH was 1026 mb. A 1002-mb LOW had moved southward to the southeast border of New Mexico. Wind reports from coastal stations and the buoys were only 10 to 15 kn. The oil drilling rig OCEAN EXPRESS was being towed to a new location off the Texas coast. The center of the LOW dropped south to a point west of Monterey, Mexico, and at 0000 on the 16th was 996 mb. The pressure gradient increased and also the winds and seas. About 40 mi northeast of Corpus Christi, the OCEAN EXPRESS was in trouble. The winds and waves were estimated at 50 to 60 mi/h and 20 to 25 ft, respectively. Reportedly, the engine of one of the three tugs holding the rig quit, the towline to another broke, and the rig swung broadside to the storm and capsized. The rig quickly sank in 187 ft of water.

There were 35 men onboard; 13 died in an inverted rescue capsule (fig. 23). The captain was rescued from the rig by a "Coast Guard helicopter from Coast Guard Air Station, Corpus Christi, Tex." The U.S. Navy aircraft carrier LEXINGTON, which was on training maneuvers in the area, picked up the two rescue capsules.

During this same storm and on the same day, the 16th, the 4,777-ton drilling platform PENROD 53 lost three legs and a derrick in the vicinity of 28.8°N, 92.7°W, while under tow to a new location. The PENROD 53 was moved to shallow waters and later towed to port for repairs. There was no indication of injuries to the crew.

Lake Superior was the source of this storm rather than the victim. It formed on the 18th and raced across Quebec Province. At 0000 on the 21st, it was over Newfoundland at 1002 mb pressure. As it moved over the water, it started to deepen. The BESS-TRASHNIJ was buffeted by 50-kn winds and 16-ft seas at 46°N, 49°W, at 0000 on the 22d. By 1200, the LOW

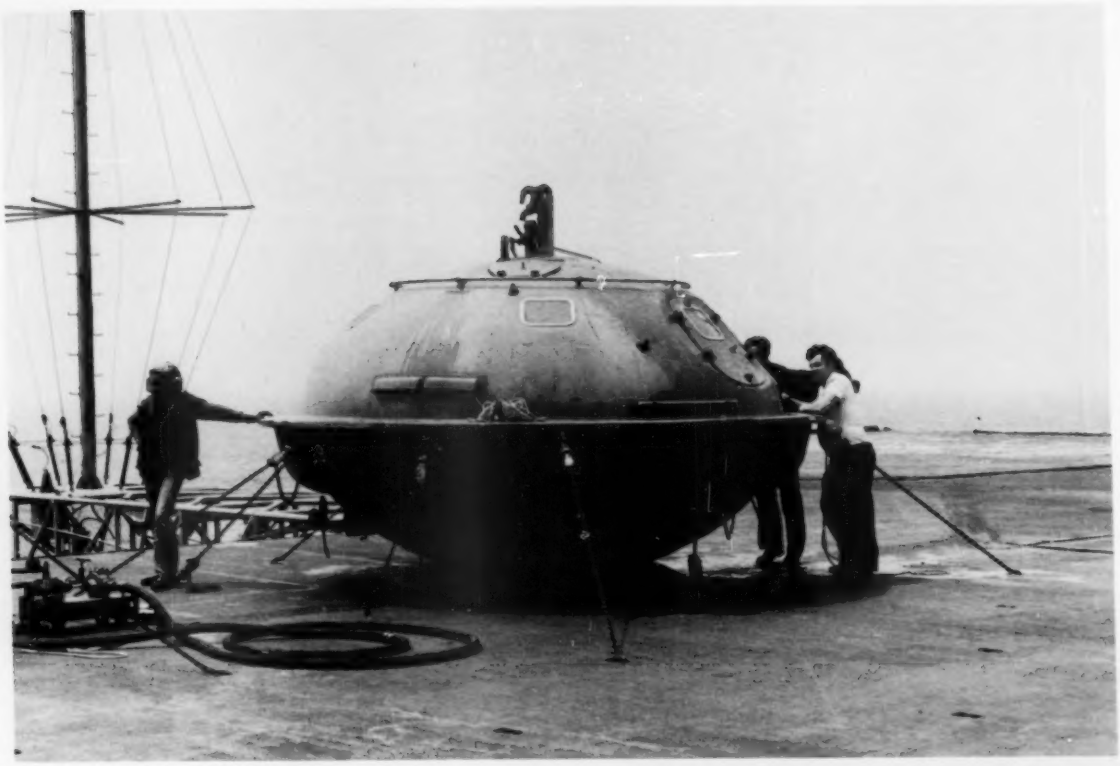


Figure 23.--The rescue capsule of the OCEAN EXPRESS tied-down on the deck of the carrier LEXINGTON. U.S. Navy Photo.

was 984 mb near 46.5°N, 42°W. The EXPORT PATRIOT logged howling 60-kn winds and giant 50-ft swells, at 44.2°N, 45.5°W, at 1800. Other ships were reporting winds of 35 to 40 kn in the western and southern quadrants with waves of 20 to 23 ft. At 0000 on the 23d, the KANAGAWA MARU was about 120 mi from the 976-mb center with 40-kn winds and 15-ft seas. The KOMPETENTNII was practically at the center with a reported pressure of 976.5 mb. Back near Newfoundland, the BESSTRASHNIJ had 50-kn winds and 34-ft seas. At 0600, the EXPORT PATRIOT had 50-kn winds and was still logging the 50-ft swells.

At 1200 on the 23d, the ABIDA (36.5°N, 46°W) had only 35-kn gales, but the swells were 31 ft. The SEALAND MARKET, at 42°N, 33.8°W, fought 50-kn winds, 33-ft seas, and 25-ft swells. Gales continued to blow in the southern half of the storm with the highest waves reported as 23 ft. About this time, the storm turned northward and weakened as another LOW approached from the west. By 1200 on the 25th, only the new LOW remained.

Casualties--The 6,400-ton Russian freighter PAVEL PARENAGO, Liverpool for Cleveland, arrived Tenerife, on the 20th, owing to alleged bad weather.

The 42,619-ton CAROLYN JANE, registered in Singapore, ran aground near 35.9°N, 14.5°E, on the 30th during inclement weather.

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

Smooth Log, North Pacific Weather

March and April 1976

SMOOTH LOG, MARCH 1976--The number of cyclones traversing the North Pacific was far above normal. The track chart north of 35°N over the western two-thirds of the ocean was a mass of lines. The lower limit of the tracks gradually migrated northward to the latitude of Seattle from approximately 160°W eastward. The major difference in the actual tracks from the climatological pattern was a more easterly than northeasterly orientation over the western half of the ocean. This resulted in tracks farther south than normal over the central ocean. A secondary track toward and over the Bering Strait was a primary track this month.

The Aleutian Low was split into two centers as is usual, but the deeper of the two (1005 mb) was over the Gulf of Alaska rather than south of the Rat Islands as is normal. The Pacific High had two centers, 1025 and 1026 mb, versus the usual 1022 mb. The 1026-mb center was near 35°N, 135°W, and the 1025-mb center was near 31°N, 174°W.

The most prominent anomaly centers were positive in association with the two high-pressure areas, 5 and 6 mb. The only significant negative anomaly was 5 mb over the Bering Sea.

The upper-air 700-mb pattern was very much like climatology with basically zonal flow over the water. A major trough was just east of Japan, and a minor trough was near 155°W. As with the surface, the primary anomaly centers were associated with the surface high-pressure centers and over the Bering Strait.

There were no tropical cyclones this month.

Extratropical Cyclones--During the first half of the month there were many cyclones over the North Pacific, but they were generally small and weak with no exceptionally high winds or seas. It was no oddity to find five or six centers over the water at one time.

At 1200 on the 9th, a wave developed on a front near 36°N, 152°W. The front moved eastward, but the LOW created by the wave remained behind and moved westward under the influence of an upper-air cutoff LOW. At 1200 on the 10th, the LOW was 1006 mb near 34°N, 156°W. That day, three ships--AMERICAN LEGION, EXPORT CHALLENGER, and PRESIDENT JEFFERSON--reported 50-kn winds in the vicinity of 35°N, 156°W. The seas were running about 15 ft and the swells up to 23 ft.

On the 11th, the IBERVILLE, at 30.7°N, 162.2°W, fought 45-kn winds, 12-ft seas, and 30-ft swells. On the 12th, the YAMASHIN MARU measured 40-kn winds and 23-ft seas near 39°N, 158°W. Other ships were reporting 40- to 45-kn winds especially on the north and northwest side of the LOW. The LOW was in the process of making a cyclonic loop. On the 13th, the EXPORT CHALLENGER had 50-kn winds, 10-ft seas, and 20-ft swells northeast of the center. The LOW was now filling, and by the 15th it had disappeared.

At 0000 on the 10th, a wave developed on a cold front south of Shikoku, Japan. It traveled eastward and deepened after crossing the Izu Trench. It was 982 mb, near 42°N, 164°E, at 0000 on the 12th. The KASUGAI MARU was north of the center, near 46°N, 160°E, with 35-kn easterlies and 21-ft seas. The LOW continued to move east-northeastward as its pressure decreased very slowly.

At 0000 on the 14th, the HOYO MARU (50°N, 177°W) was 360 mi west of the center with only 40-kn gales, but the seas were 10 ft and the swells 28 ft. At 1200, two more ships reported 40-kn gales, but the waves were in the 20-ft range. On the 15th, several small LOWs developed, and one of these became the primary circulation on the 16th.

About 36 hr after the previous LOW formed, another developed south of Kyushu. The center moved south of the Islands before turning northward on the 13th. At 0000 on the 14th, the 990-mb storm was near 43°N, 160°E. The SEPTA was whipped by 50-kn winds near 43°N, 166°E. At the same time, there were four reports of 40-kn gales in other quadrants of the storm. The highest waves were 18 ft.

As the LOW approached the Kamchatka Peninsula, Ostrov Beringa measured 50-kn winds. At 1200 on the 15th, the storm was curving eastward south of the Island which now measured 70-kn winds. The ZARETCHIE, at 52°N, 176°E, experienced 45-kn winds and 23-ft seas at the occlusion. The storm continued eastward and was absorbed by another circulation on the 16th.

As the previous storm moved northward, it left a trough that extended over the Sea of Japan. As the trough moved across Hokkaido, a 1002-mb LOW formed over Ostrov Iturup at 1200 on the 15th. This LOW quickly developed a large circulation as the original storm deteriorated. By 1200 on the 16th, it was 982 mb near 50°N, 156°E. The TOKO MARU, near 39°N, 154°E, reported 40-kn gales. At 0000 on the 17th, the PAN EASTERN (42°N, 159°E) had roaring 60-kn westerlies. Ostrov Simushir measured 50-kn northwesterlies. The PRESIDENT MCKINLEY braved 45-kn southeasterlies and 20-ft seas at 42.8°N, 175°E.

On the 18th, the 986-mb LOW was moving eastward. A fishing boat near Kiska Island found fishing rough in 40-kn gales. The NICHIHARU MARU was north of the Aleutians, at 0000 on the 19th, with 35-kn gales and 23-ft swells. South of the center, near 42°N, 174°E, the PAN EASTERN again encountered 60-kn winds. At 0000 on the 20th, a ship reported 60-kn winds near 44°N, 165°W, near a trough line.

On the 21st, this LOW and another combined with rapid deepening. At 0000, a ship with no call sign printed, near 47°N, 150°W, and about 100 mi south of the 978-mb center, reported 65-kn winds from the west, with 16-ft seas and 20-ft swells. The 969-mb LOW moved directly over Ocean Weather Station Papa about 0800. At 1200, the ASIA HONESTY measured 50-kn winds and 25-ft swells. At 0000 on the

22d, the ARCO PRUDHOE BAY (49.6°N, 137.4°W) estimated only 40-kn winds with 36-ft seas and 39-ft swells. Papa measured 50-kn winds with 26-ft seas, and the EIYO MARU (52°N, 153°W) had the same winds with 16-ft seas and 23-ft swells. Other ships farther south were having only 30-kn gales, but the swells were running 25 ft. By 1200, Papa's wind was only 40 kn, but the seas had increased to 30 ft.

On the 23d, the storm stalled, near 57°N, 145°W, to disappear on the 24th. Earlier, a wave had formed on the front and was racing around the periphery of the storm. On the 24th at 1800, this new circulation went ashore at Vancouver Island, and the HAWAIIAN CITIZEN at 45.4°N, 125.3°W, fought 60-kn winds, 21-ft seas, and 41-ft swells. Nearby, the ARCO SAG RIVER had 36-ft swells.

A frontal wave was analyzed, near 40°N, 177°W, at 1200 on the 23d, thanks to a report from the OREGON MAIL. The LOW moved northeastward and was 988 mb, near 50°N, 155°W, at 0000 on the 25th. At that time, a ship near the occlusion (46°N, 150°W) was plotted as reporting swell code 31 or 51 ft. Code 13 (21 ft) would be more reasonable compared with other reports.

At 0000 on the 26th, the 980-mb LOW was near 53°N, 140°W. A ship, at 54°N, 145°W, reported 65-kn winds in a heavy thunderstorm with hail. To the south, OWS Papa had 45-kn winds and 21-ft seas. Farther south, at 44°N, 140°W, the ROSE S. contended with 23-ft swells. On the 26th, the storm crossed the coast of Alaska into the Northwest Territories.

This LOW moved out of the Yellow Sea on the 26th. It moved across Japan, and at 1200 on the 27th, it was 992 mb near 39°N, 148°E. A ship reported 23-ft waves about 350 mi south of the center. The SEA-LAND COMMERCE (34.8°N, 150.5°E) battled 60-kn winds and 20-ft seas. The PRESIDENT GRANT (33.4°N, 145.2°E) was sailing with 50-kn winds, 20-ft seas, and 200-yd visibility. On the 28th, the SEA-LAND FINANCE (41.1°N, 155.1°E) estimated 55-kn winds and 20-ft waves, as did the SUENDBORG MAERSK, near 38.8°N, 155°E. There were three reports of 40-kn winds ranging from southwest to northwest of the center.

By 0000 on the 30th, the LOW was 974 mb near 51°N, 171°E. A ship at 44°N, 177°E, had 45-kn winds. Waves in the area were about 15 ft. Twelve hours later, the TAIKAI MARU (46°N, 172°E) found 25-ft swells. At 0000 on the 31st, a ship near 52°N, 166°W, was plotted with swell code 41 (67 ft). The ship's code could not be deciphered because of the 35-kn wind barb. The seas were listed as 13 ft. On the 31st, the ALEUTIAN DEVELOPER, at 52.2°N, 170°W, measured 70-kn hurricane-force winds. The storm was now weakening over the Bering Sea. At 1200, the DATAN MARU (49°N, 177°W) was sailing into 45-kn winds and 20-ft seas. On April 1, the LOW was gone.

This storm formed on the 29th in the same vicinity as the previous one and closely followed the same track. After crossing Japan, it deepened to 985 mb near 43°N, 154°E. On the 31st, gale-force winds were blowing in all quadrants. At 1200 on the 1st, the 972-mb storm was near 54°N, 173°E. The BREWSTER, at 51°N, 167°E, was mauled by winds of 50 kn from the northwest. The seas were listed as 20 ft. Three hundred miles to the south, the ASAISHI MARU was sailing with 45-kn winds and 23-ft swells.

At 0000 on the 2d, the DATAN MARU (48°N, 177°E) came in with 55-kn winds. The KORENGA (52°N, 177°E) had 50-kn winds and 16-ft seas.

On the 3d, the LOW moved into Bristol Bay. In the latitude band of 45° to 50°N, three ships had 40- and 45-kn winds with seas and swells of 26 to 30 ft. At 1200 on the 3d, a ship at 51.5°N, 156°W, reported 49-ft swells.

On the 4th, the LOW split as it crossed the Alaska Peninsula. One center moved toward the Bering Strait, and the other remained stationary near Kodiak Island.

Casualties--The 2,994-ton Panamanian-registered HANDSOME sank after a collision with the 3,404-ton Korean YOUNG DUCK, in fog, on the 10th near 37.2°N, 126.4°E. The crew was rescued. The 15,498-ton Indian JAG SHAKTI, from Seattle, was at Madras on the 25th, with heavy weather damage. The 2,958-ton Japanese SENYO MARU sank in stormy seas off Taiwan on the 19th. Eighteen of the 24 crewmen were rescued. All 30 crew members of the Korean freighter SHINYANG (1,599 tons) were rescued after a collision in poor visibility with the 14,000-ton Japanese freighter CHUKO MARU off the entrance to Yokohama port on the 31st.

SMOOTH LOG, APRIL 1976--The North Pacific lived up to its name this month. There were more low-pressure centers, and, therefore, they were generally smaller and not as intense. Along the western shore the storms moved off the continent or originated farther south than usual. Also, the LOWs tracked more easterly than the normal northeasterly direction. The storm track along the Aleutians was normal and consisted mainly of the northernmost storms rather than the southern ones. A secondary storm track out of the central ocean into the Gulf of Alaska became a primary track. There were two obvious crossroads where storm tracks crossed at large acute angles. The mean locations were near 52°N, 173°W, and 47°N, 158°W.

The mean pressure pattern was more intense than climatology. As usual, the Aleutian Low and the Pacific High dominated the picture. The April climatology indicated the Aleutian Low is split into four centers along approximately 58°N, with the deepest center 1009 mb. This month there was one main center at 1004 mb over Kodiak Island, with a lesser center of 1011 mb inland of Sakhalin Island. The Pacific High had two 1026-mb centers along latitude 32°N at longitudes 175°W and 153°W. According to climatology there are three centers: 1021 mb at 30°N, 170°E; 1022 mb at 33°N, 157°W; and 1023 mb at 33°N, 146°W.

The anomaly pattern was weak. A negative 6 mb was south of Kodiak Island with a negative anomaly trough paralleling the Aleutian Islands and the primary concentration of storm tracks. A large block-shaped area of positive values was bounded by latitudes 20° and 40°N and longitudes 170°E and 140°W, with two

positive 4-mb centers.

The upper-air flow at 700 mb was zonal following the parallels of latitude except for a shallow trough off the Asian coast and a sharper trough off the North American coast. There was an anomalous low center near Wrangel Island with an associated negative anomaly center. Another negative anomaly center was over the Fox Islands. A positive anomaly center was near 35°N, 170°W.

There were two tropical cyclones--typhoon Marie and tropical storm Nancy.

Extratropical Cyclones--The most violent storm of this month originated in March, so it is written up in that month. This storm followed on the heels of that storm. It moved out of Manchuria and across the Sea of Japan on the 2d. At 0000 on the 3d, it was 994 mb near Ostrov Iturup. The SANTA MONICA MARU was southeast of the center and east of the occlusion, near 42°N, 158°E, with 40-kn southerly winds and 16-ft waves. At 1200, the BREWSTER was in the vicinity of 47°N, 159°E, and ahead of the center. She was mauled by 70-kn winds from the southwest. On the 4th, the REXTAR was sailing into 30-ft seas and swells near 48°N, 173°E.

The storm continued to track eastward, and at 0000 on the 5th, it was 980 mb near 52°N, 169°W. Four ships fought 40-kn winds. One of the ships with the first three call letters of A8I, near 40°N, 168°W, also contended with 20-ft seas and 36-ft swells. The SHOGEN MARU, near 47°N, 180°, had 26-ft swells.

On the 6th, the storm was headed southeastward as was the TAEPING. At 38.7°N, 148.2°W, she had 50-kn winds and 36-ft seas. Many ships were finding winds over 40 kn. At 0000 on the 7th, the PFQU was at 39°N, 143°W, with 55-kn northwesterly winds, 25-ft seas, and 33-ft swells. The PACEMPEROR, along with several other ships, had 40-kn gales, but the swells were 30 ft. A ship off the northern California coast had 45-kn gales. As the storm center approached 130°W, it turned northward. The NORSE PILOT, at 32.8°N, 136.3°W, measured 32-kn winds, 13-ft seas, and overwhelming 41-ft swells from the northwest. Late on the 8th, the storm dissipated against the rocky coast.

An unstable wave formed on a cold front south of Kyushu on the 3d. It moved eastward, then northeastward, until it was 998 mb, near 40°N, 165°E, at 1200 on the 5th. The HAGOROMO MARU (39°N, 160°E) had heavy rain driven by 45-kn winds. A ship northeast of the center had 40-kn gales. Winds of 40 kn continued as the storm deepened and continued its northeastward track. At 2000 on the 6th, the VAN FORT made a special observation which measured 65-kn winds and 37-ft swells near 48.2°N, 176.8°W.

At 0000 on the 7th, the center was near 52°N, 176°W, and 968 mb. The VAN FORT was now measuring 62 kn. The CRESSINDA measured 60 kn at 52.8°N, 173°W, with 24-ft seas and 26-ft swells. A ship found 50-kn winds at 47°N, 180°, and another ship had 40-kn winds near 47°N, 174°W, with 30-ft swells. At 1200, the LOUIS L. D. also battled 50-kn winds at 51°N, 172°W. Gale-force winds continued as the storm moved along the Aleutians, but the storm was decreasing in intensity. Late on the 8th, the storm turned northwestward when over Bristol Bay and was absorbed by the next storm on the 10th.

This LOW appeared off Japan almost fully developed. At 0000 on the 7th, it was 994 mb and by 1200 was 972 mb. There were three reports of winds of 50 kn around the center: the DAIAN MARU near 41°N, 145°E, and two other ships whose call letters could not be read. Some distance to the south, the LEVEN FISHER (34°N, 145°E) had only 40-kn winds with 20-ft waves.

Early on the 8th, the ZEALAND VENTURE measured 53-kn winds and 36-ft swells near 42.1°N, 149.7°E. The HIKAWA MARU had 40- and 45-kn winds with 25- and 30-ft waves. At 1200, the YAMATADA MARU was near 41°N, 149°E, with 50-kn winds. Another LOW had formed south of the main center and was rotating around the eastern side. South of the primary center (972 mb), the TOKUYO MARU had 45-kn winds, 20-ft seas, and 26-ft swells. Far to the south, the OJI MARU (38°N, 164°E) and another ship to the east fought 40-kn winds and seas up to 23 ft.

The storm was moving fairly slowly toward the northeast. The INDIAN MAIL (43°N, 166°E) was sailing into 35-kn gales with 16-ft seas, and 41-ft swells. To the west, the WRANGELL MARU (43°N, 157°E) had 45-kn northwesterly winds, 23-ft seas, and 33-ft swells. The PACIFIC BEAR measured 50-kn winds and 41-ft seas near 51°N, 166.5°E.

The storm started weakening on the 10th, but it did not quiet the 44-ft swells the INDIAN MAIL found at 42.7°N, 165.3°E. The storm split into two centers with the original one disappearing. The other center which was to the north continued northeastward. The JAMSONS was at 44°N, 171°W, with 45-kn gales and 20-ft swells. This LOW moved through the Bering Strait and into the Chukchi Sea.

The reports from Midway Island and two ships, the OREGON STANDARD and SEALAND FINANCE, on the 14th, identified this frontal wave. It raced northeastward and was 977 mb, at 0000 on the 16th, near 50°N, 156°W. Ocean Weather Station Papa measured 40-kn winds, and a ship nearer the center had 16-ft seas. At 0000 on the 17th, the LOW was producing 45-kn winds and high swells. One of the ships, near 52°N, 154°W, reported 41-ft swells, and the other, the KIKUKO MARU (53°N, 147°W), had 21-ft swells. On the 18th, the storm died out as it stalled off the coast of Alaska.

This storm originated on the 21st. It moved northeastward and was near 52°N, 174°E, at 996 mb on the 23d. The THOMAS E. CUFFE found 45-kn gales and 20-ft swells near 44.6°N, 179.4°E, at 1200 on the 24th. On the 25th, the EATON GLORIA (47.2°N, 158.2°W) measured 50-kn winds and the TRIUMPH (49°N, 161.5°W) measured 44-kn winds with 31-ft seas and swells. The 990-mb LOW was near 47°N, 156°W. On the 26th, the chart showed the LOW split into two centers with a third racing southeastward from the Bering Sea to join the overall circulation. The EATON GLORIA measured 55-kn winds at 47.9°N, 145.1°W.

On the 27th, the new northern LOW moved into Cook Inlet, and the original LOW was absorbed by the Bering Sea LOW, which continued moving southeastward until the 29th. It suddenly turned northward and then northwestward on May 1 to dissipate on the 2d.

On the 29th, a LOW formed over Hokkaido and moved eastward with snow over the Kuril Islands. At 0000

(continued on page 300)

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

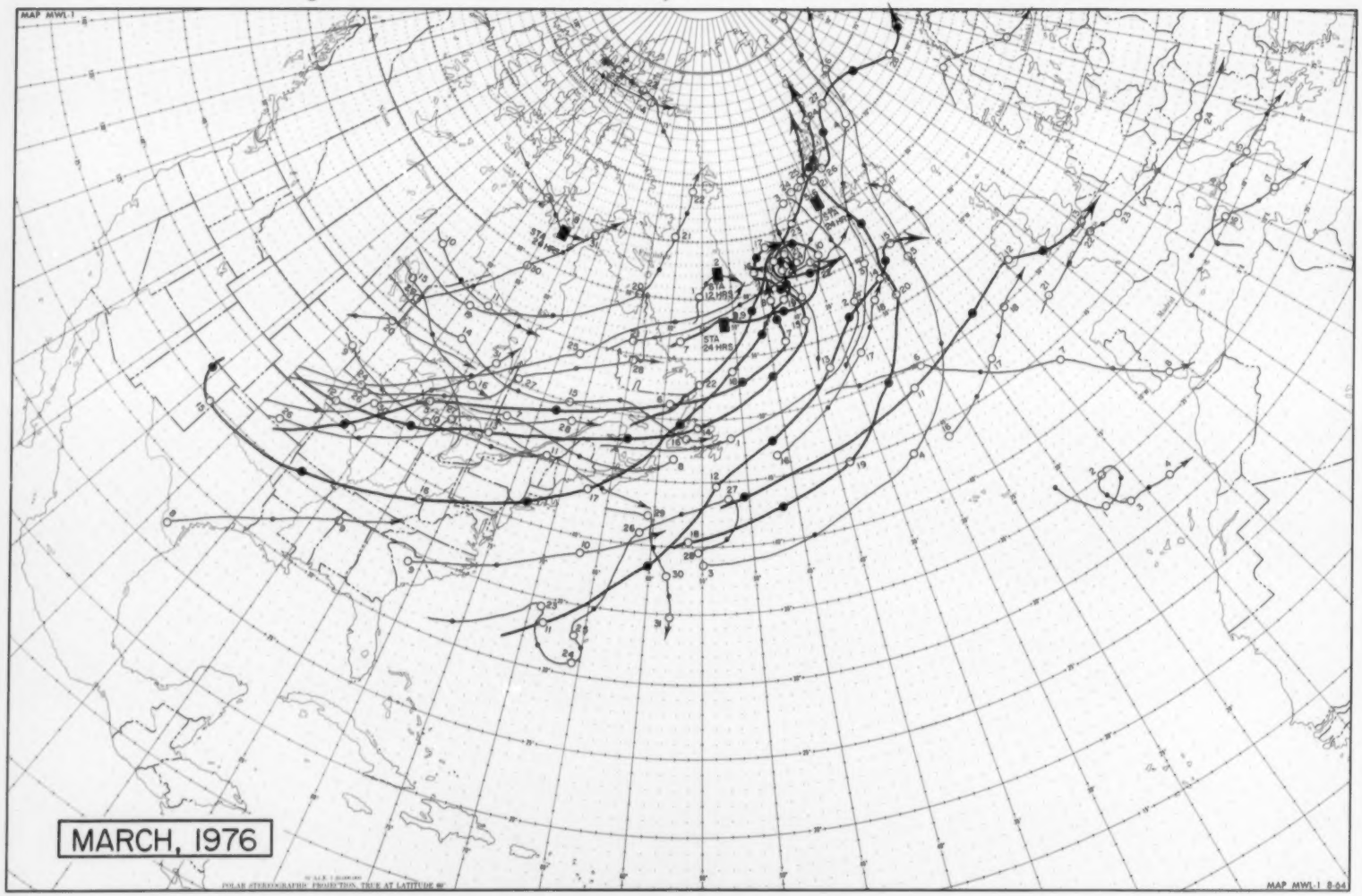


Figure 24. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

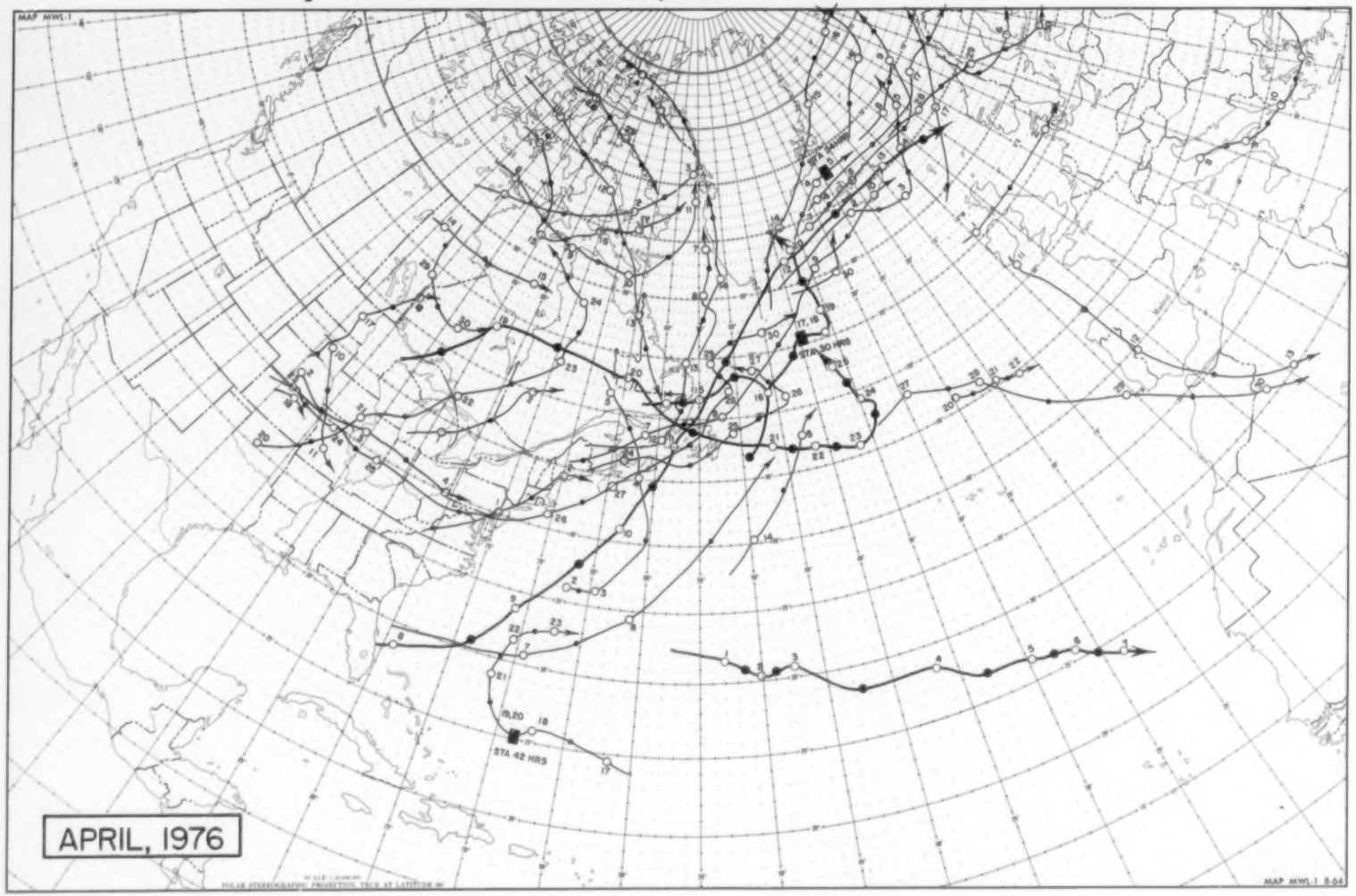


Figure 25.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

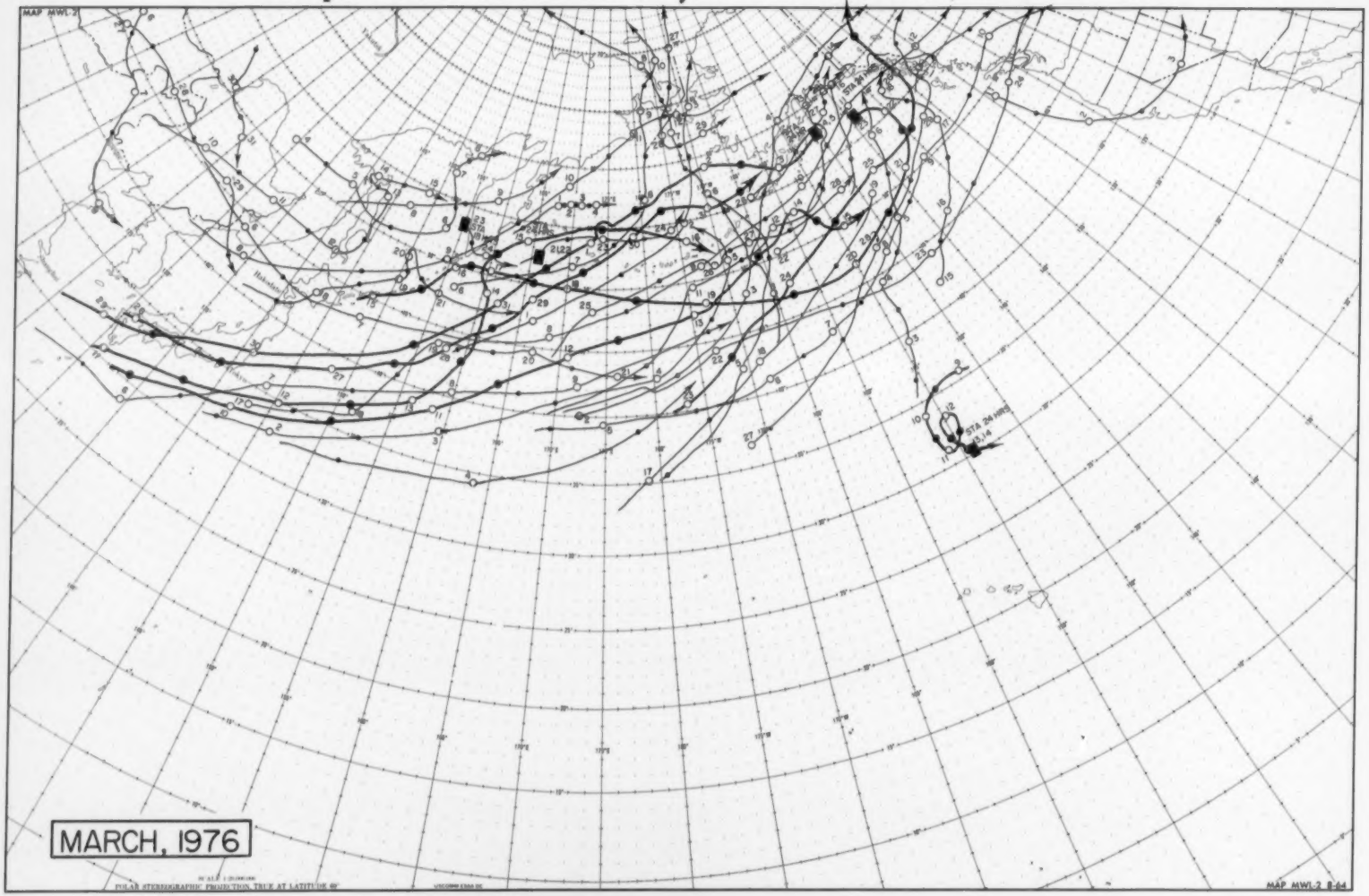


Figure 26. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

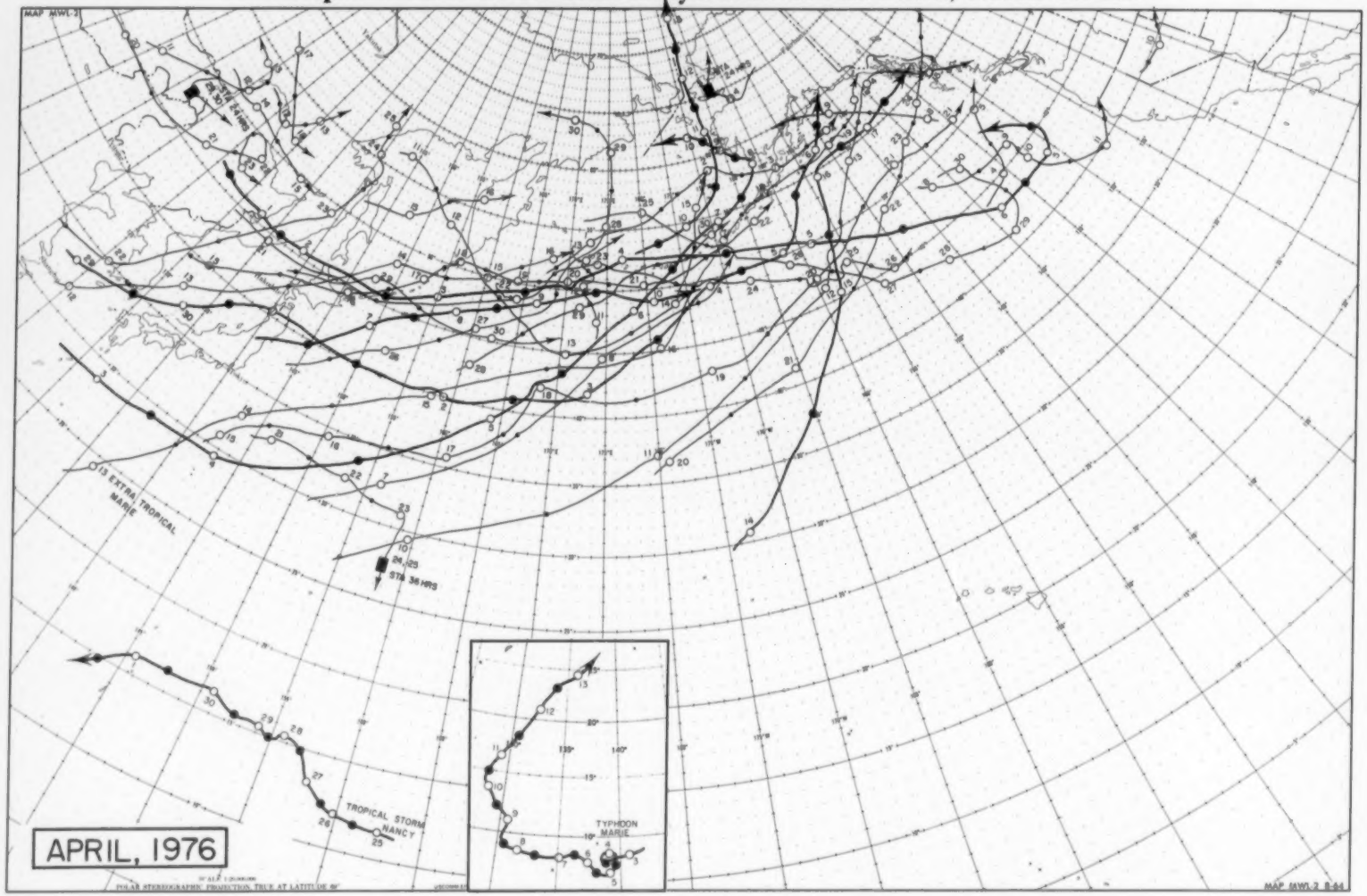


Figure 27. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 4
U. S. Ocean Weather Station Climatological Data, North Atlantic

Ocean Weather Station 'HOTEL' 38°00'N 71°00'W **March and April, 1976**

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C)					DEW-POINT TEMP (°C)					SEA TEMP (°C)					AIR-SEA TEMP DIFFERENCE (°C)				
	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR
MAR	2.0	18 15	11.1	17.8	13 21	- 6.8	18 06	6.6	10.0	17 21	11.0	*09 12	13.6	16.1	20 15	-11.8	18 15	- 2.5	3.7	06 09
APR	3.0	*12 13	11.4	21.9	15 18	- 5.9	13 09	5.3	14.4	01 18	7.7	06 03	13.3	23.9	15 18	-10.3	12 12	- 2.1	2.9	01 18

MONTH	MEANS AND EXTREMES PRESSURE (MB)					PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS) TOTAL CLOUD				LOW CLOUD				DAYS WITH SPECIFIED WEATHER RAIN OR DRIZL				VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
	MIN	DA HR	MEAN	MAX	DA HR	0-2	3-5	6-7	8 & OBSC	0-2	3-5	6-7	8 & OBSC	PCPN	DRIZL	SNOW	TSTM						
MAR	986.5	17 03	1019.1	1032.8	24 13	25.0	13.7	22.6	38.7	52.8	10.9	13.7	22.6	13	13	3	0	4	6	1	0	31	12.3	248
APR	1002.1	04 21	1014.3	1029.2	19 15	46.6	9.1	14.1	32.2	69.3	10.2	13.3	9.3	7	7	1	0	0	3	2	0	13	11.9	118

** VV-90-93 AND/OR W-4 COMP OB DAYS-COMPLETE OB DAYS

Wind

MAR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.7	6.7	8.8	2.6	.7	.0	19.5	14.2
NE	1.7	5.2	2.6	.9	.1	.0	10.2	9.3
E	.7	1.6	.6	.4	1.2	.0	4.7	16.9
SE	1.7	2.4	1.0	1.2	.0	.0	6.4	11.0
S	.7	2.9	1.9	1.4	.0	.0	7.0	13.2
SW	.4	3.8	10.2	2.7	1.2	.0	18.3	16.4
W	.0	4.1	5.9	1.9	.0	.3	11.9	14.8
NW	.5	2.8	6.9	5.3	4.0	.5	20.1	22.8
CALM	2.0	.0	.0	.0	.0	.0	2.0	.0
TOTAL	8.5	29.8	37.9	16.1	7.3	.8	100.0	15.5

NUMBER OF OBS 248 | MAX WIND DIR 310 SPEED 50 DA 17 HR 1500 | VECTOR SPEED 6.2 | MEAN DIR 301 | (DIR IN DEGREES)

APR WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.8	1.7	3.4	.6	3.4	3.4	12.9	20.3
NE	3.4	1.3	2.1	1.7	.2	.8	8.7	12.8
E	1.7	3.0	.6	.0	.0	.0	5.3	6.3
SE	.8	1.9	.8	.0	.0	.0	2.8	9.1
S	.6	1.3	1.7	.6	.0	.8	3.9	11.8
SW	1.1	2.1	2.8	1.1	.0	.0	7.0	12.2
W	.6	3.1	14.8	4.7	.3	.0	24.4	15.9
NW	1.9	3.0	10.0	19.1	1.3	.0	35.2	21.8
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	10.2	19.5	34.7	27.1	5.1	3.4	100.0	18.4

NUMBER OF OBS 118 | MAX WIND DIR 360 SPEED *52 DA 10 HR 0000 | VECTOR SPEED 12.5 | MEAN DIR 315 | (DIR IN DEGREES)

Wave

MAR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	1.4	5.2	6.6	.3	.7	.0	.0	.0	14.2
NE	1.0	5.1	4.7	2.8	.5	.0	.0	.0	14.2
E	.7	2.0	1.3	1.2	.8	.0	.0	.0	6.0
SE	.8	1.8	1.5	.4	.0	.0	.0	.0	4.5
S	.0	4.5	2.3	2.1	.9	.0	.0	.0	9.8
SW	.0	3.2	5.9	1.5	1.2	.0	.0	.0	13.9
W	.0	2.0	2.1	.4	.7	.0	.0	.0	5.2
NW	.1	3.4	7.0	4.1	3.7	2.0	.8	.8	20.4
IND	.8	8.5	1.6	1.8	.0	.0	.0	.0	12.9
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	4.8	37.9	33.1	14.5	7.7	2.0	.0	.0	100.0

NUMBER OF OBS 248 IND-INDETERMINATE

APR WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	2.3	1.3	.6	.0	1.3	4.9	.0	.0	10.4
NE	1.1	2.8	3.0	1.7	1.9	.8	.0	.0	11.2
E	2.3	.3	2.1	.0	.0	.0	.0	.2	5.3
SE	.0	.0	.0	.0	.0	.0	.0	.0	.0
S	.0	.0	1.7	.0	.0	.0	.0	.0	1.7
SW	.0	3.8	1.3	.2	.0	.0	.0	.0	5.1
W	.0	10.0	7.2	2.1	.0	.0	.0	.0	19.3
NW	1.7	3.0	7.8	17.2	.2	.2	.0	.0	30.7
IND	1.7	7.6	3.8	.0	.0	.0	.0	.0	14.1
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	9.3	29.7	28.5	21.2	3.4	5.9	.0	.0	100.0

NUMBER OF OBS 118 IND-INDETERMINATE

MAR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	3.6	14.5	10.9	.8	.0	.0	.0	.0	29.8
6-7	.4	10.9	12.1	6.9	1.2	.8	.0	.8	31.5
8-9	.0	4.0	7.3	6.0	6.3	2.0	.0	.0	25.8
10-11	.0	.0	.4	.0	.0	.0	.0	.0	.4
12-13	.0	.0	.8	.0	.0	.0	.0	.0	.8
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.8	8.5	1.6	1.6	.0	.0	.0	.0	12.5
TOTAL	4.8	37.9	33.1	14.5	7.7	2.0	.0	.0	100.0

NUMBER OF OBS 248 | MAX WAVE HEIGHT HGT 7.9 PER 9 DIR 310 TYPE SEA DA HR 17 19 | IND-INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

APR WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	7.6	16.9	13.6	.8	.0	.0	.0	.0	39.0
6-7	.0	4.2	3.9	19.5	1.7	.8	.0	.0	32.2
8-9	.0	.8	4.2	.8	1.7	5.1	.0	.0	12.7
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	1.7	7.6	6.8	.0	.0	.0	.0	.0	16.1
TOTAL	9.3	29.7	28.5	21.2	3.4	5.9	.0	.0	100.0

NUMBER OF OBS 118 | MAX WAVE HEIGHT HGT 7.0 PER 9 DIR 360 TYPE SEA DA HR 10 06 | IND-INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 5
U. S. Ocean Buoy Climatological Data
March and April 1976

MARCH DATA SUMMARY 8803
AVERAGE LATITUDE 36.0N AVERAGE LONGITUDE 147.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-09.0	(18 12)	01.1	04.1	(07 00)	246	31
DEWPOINT TEMP (DEG C)	-09.0	(18 21)	-02.2	00.0	(09 06)	217	30
PRESSURE (MBAR)	0980.5	(27 06)	1006.0	1029.9	(01 21)	249	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)	NO. OF OBS: 249
N			1.6		4.1	13.1	MAX WIND
NE	.4	2.0			4.9	11.0	SPEED: 34 KNOTS
E		3.0	3.0	.4	4.9	13.4	DIRECTION: 270 DEG
SE		.8	3.7		4.9	12.2	DAY: 27
S		2.4	2.4	.4	5.3	12.4	HOUR: 18
SW		1.6	4.1	0.8	12.2	20.2	
W		2.4	11.4	2.4	18.9	18.4	
NW		4.9	16.8	12.2	33.9	18.8	
NW		4.1	8.6	9.7	18.4	17.1	
CALM	.4				.4	0.0	
TOTAL	1.2	20.4	48.6	29.4	100.0	16.8	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 230

HEIGHT (M)	CL	1-1.9	2-2.9	3-3.9	4-5.9	6-7.9	8-9.9	10.9	MEAN	MAX	(DA HR)
% FREQUENCY		14.8	45.2	27.0	13.0				2.9M	8.5M	(27 21)

PRECIPITATION
NO. OF DAYS WITH PRECIP: 12 NO. OF DAYS WITH REPORTS/ COMPLETE: 30 PARTIAL: 1
NO. OF OBS WITH PAST OR PRESENT PRECIP: 27 NO. OF WEATHER OBS: 27

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING MODERATE: 4.9% SEVERE: NONE NOBS: 249

APRIL DATA SUMMARY 8803
AVERAGE LATITUDE 36.0N AVERAGE LONGITUDE 147.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-01.0	(03 12)	01.8	09.9	(06 03)	98	13
DEWPOINT TEMP (DEG C)	-06.0	(06 03)	-00.6	02.4	(12 00)	98	13
PRESSURE (MBAR)	0989.0	(03 12)	1002.9	1014.7	(07 09)	98	13

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOT.)	NO. OF OBS: 98
N		2.0			2.0	7.0	MAX WIND
NE	1.0	1.0			2.0	4.5	SPEED: 21 KNOTS
E	2.0		2.0		4.1	8.0	DIRECTION: 140 DEG
SE		2.0	3.1	2.0	9.2	10.7	DAY: 02
S		9.1	14.3	4.1	29.5	14.2	HOUR: 19
SW		3.1	20.5	1.0	30.6	13.7	
W		7.1	10.2		17.3	13.1	
NW	1.0	4.1	6.1		11.2	8.9	
CALM							
TOTAL	4.1	28.4	64.3	9.2	100.0	14.9	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 99

HEIGHT (M)	CL	1-1.9	2-2.9	3-3.9	4-5.9	6-7.9	8-9.9	10.9	MEAN	MAX	(DA HR)
% FREQUENCY		1.1	10.9	35.0	39.4	24.2			2.9M	5.0M	(09 00)

PRECIPITATION
NO. OF DAYS WITH PRECIP: 8 NO. OF DAYS WITH REPORTS/ COMPLETE: 12 PARTIAL: 1
NO. OF OBS WITH PAST OR PRESENT PRECIP: 17 NO. OF WEATHER OBS: 17

MARCH DATA SUMMARY 8804
AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 090.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	17.1	(17 12)	22.1	29.4	(21 21)	239	30
DEWPOINT TEMP (DEG C)	09.8	(17 18)	20.2	23.5	(29 18)	177	30
SEA TEMP (DEG C)	21.1	(02 15)	22.7	24.3	(14 18)	234	30
AIR-SEA TEMP (DEG C)	-09.4	(17 09)	-00.6	01.2	(09 18)	233	30
PRESSURE (MBAR)	1008.0	(09 00)	1015.9	1029.3	(29 15)	239	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)	NO. OF OBS: 236
N	1.3	2.1	1.3		4.7	10.6	MAX WIND
NE	3.0	8.9	3.0		14.8	13.3	SPEED: 27 KNOTS
E	9.7	23.8			33.6	12.4	DIRECTION: 140 DEG
SE	.4	3.0	23.0	2.5	28.9	14.7	DAY: 09
S		.8	4.2		5.1	12.9	HOUR: 12
SW		.4	.4		.8	10.0	
W		.4	.8		1.3	12.5	
NW			1.3		1.3	16.3	
CALM							
TOTAL	.4	21.0	71.2	6.8	100.0	13.9	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 227

HEIGHT (M)	CL	1-1.9	2-2.9	3-3.9	4-5.9	6-7.9	8-9.9	10.9	MEAN	MAX	(DA HR)
% FREQUENCY		20.3	67.8	11.9					1.2M	2.5M	(20 18)

PRECIPITATION
NO. OF DAYS WITH PRECIP: 2 NO. OF DAYS WITH REPORTS/ COMPLETE: 28 PARTIAL: 2
NO. OF OBS WITH PAST OR PRESENT PRECIP: 2 NO. OF WEATHER OBS: 2

APRIL DATA SUMMARY 8804
AVERAGE LATITUDE 26.0N AVERAGE LONGITUDE 090.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	19.9	(01 18)	22.5	28.4	(20 21)	239	30
DEWPOINT TEMP (DEG C)	10.2	(02 15)	19.1	22.9	(27 15)	233	30
SEA TEMP (DEG C)	22.3	(09 12)	23.5	25.6	(20 21)	239	30
AIR-SEA TEMP (DEG C)	-03.7	(01 09)	-00.8	02.1	(21 18)	197	30
PRESSURE (MBAR)	1007.0	(06 09)	1012.9	1023.7	(12 15)	239	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)	NO. OF OBS: 230
N	.4	1.3	7.3	.4	9.6	13.8	MAX WIND
NE	.4	2.9	13.0		19.2	13.1	SPEED: 29 KNOTS
E	1.7	18.0	29.0	2.9	48.1	12.0	DIRECTION: 110 DEG
SE	1.7	3.0	6.1		10.9	10.9	DAY: 16
S	1.7	2.3	.4		4.4	8.4	HOUR: 06
SW	1.7	.8	.4		2.9	9.7	
W		.4	.8		1.3	13.0	
NW		.4	.8		1.3	10.3	
CALM							
TOTAL	7.5	31.0	58.2	3.3	100.0	11.9	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 238

HEIGHT (M)	CL	1-1.9	2-2.9	3-3.9	4-5.9	6-7.9	8-9.9	10.9	MEAN	MAX	(DA HR)
% FREQUENCY		42.0	46.6	10.1	1.3				1.0M	3.0M	(18 12)

PRECIPITATION
NO. OF DAYS WITH PRECIP: 3 NO. OF DAYS WITH REPORTS/ COMPLETE: 30 PARTIAL: 0
NO. OF OBS WITH PAST OR PRESENT PRECIP: 5 NO. OF WEATHER OBS: 5

MARCH DATA SUMMARY 8819
AVERAGE LATITUDE 32.0N AVERAGE LONGITUDE 079.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	11.5	(17 15)	18.9	22.8	(25 18)	244	31
SEA TEMP (DEG C)	20.6	(02 12)	21.6	23.4	(10 15)	247	31
AIR-SEA TEMP (DEG C)	-09.0	(17 18)	-02.7	01.0	(24 15)	244	31
PRESSURE (MBAR)	1014.8	(19 21)	1021.0	1029.3	(24 15)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)	NO. OF OBS: 247
N	.8	4.9	4.9	1.2	11.7	11.0	MAX WIND
NE		2.4	5.7	1.6	.4	10.1	16.0	SPEED: 39 KNOTS
E	.4	4.0	4.5	.4		9.3	11.2	DIRECTION: 040 DEG
SE		2.4	3.6	.4		6.1	12.6	DAY: 23
S	1.2	3.6	10.1	3.6		28.7	15.2	HOUR: 12
SW	.4	3.2	13.0	9.3		21.9	17.2	
W		2.0	3.6	.4		6.1	13.3	
NW	.4	2.0	4.5	.4	.4	7.7	14.4	
CALM	.8					.8	.0	
TOTAL	4.0	24.7	57.5	19.0	.8	100.0	14.4	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 247

HEIGHT (M)	CL	1-1.9	2-2.9	3-3.9	4-5.9	6-7.9	8-9.9	10.9	MEAN	MAX	(DA HR)
% FREQUENCY		19.0	51.0	19.4	8.5	2.0			1.5M	5.0M	(17 00)

APRIL DATA SUMMARY 8819
AVERAGE LATITUDE 32.0N AVERAGE LONGITUDE 079.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	12.1	(10 06)	19.0	25.3	(24 18)	239	30
SEA TEMP (DEG C)	20.2	(11 03)	21.8	24.0	(28 21)	239	30
AIR-SEA TEMP (DEG C)	-08.9	(10 06)	-02.8	02.3	(24 18)	239	30
PRESSURE (MBAR)	1004.3	(09 09)	1012.9	1029.3	(10 18)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)	NO. OF OBS: 239
N	1.3	2.5	5.0	2.9	.8	11.3	16.4	MAX WIND
NE	.4	4.2	7.9	1.7		13.8	19.2	SPEED: 36 KNOTS
E	1.3	9.6	7.9	9.2		18.0	14.2	DIRECTION: 010 DEG
SE	.4	2.5				2.9	9.0	DAY: 09
S	2.1	5.4	6.3	1.3		15.1	11.1	HOUR: 18
SW	.4	5.4	5.0	5.9		16.7	15.0	
W		2.9	4.2	2.1		9.2	14.4	
NW	1.3	2.9	5.4	1.7		11.3	13.9	
CALM	1.7					1.7	.0	
TOTAL	8.8	31.4	42.2	19.8	.8	100.0	13.8	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 240

HEIGHT (M)	CL	1-1.9	2-2.9	3-3.9	4-5.9	6-7.9	8-9.9	10.9	MEAN	MAX	(DA HR)
% FREQUENCY		36.0	29.6	17.9	12.5	1.3			1.3M	4.3M	(09 18)

MARCH DATA SUMMARY 8814
AVERAGE LATITUDE 42.0N AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	04.2	(01 00)	08.4	10.8	(21 18)	245	31
SEA TEMP (DEG C)	09.3	(29 15)	09.6	10.3	(12 00)	246	31
AIR-SEA TEMP (DEG C)	-09.9	(01 03)	-01.2	01.3	(21 18)	243	31
PRESSURE (MBAR)	1009.0	(18 12)	1021.9	1032.4	(11 21)	246	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)	NO. OF OBS: 179
N		.6	9.2	2.9	8.7	17.8	MAX WIND
NE		.6			.6	7.0	SPEED: 38 KNOTS
E	.6				.6	1.0	DIRECTION: 280 DEG
SE		.6			.6	7.0	DAY: 24
S		1.7	10.6	4.0	16.2	17.0	HOUR: 12
SW		2.3	19.0	9.5	29.7	18.8	
W	1.7	2.3	11.1	11.4	25.7	18.9	
NW		2.3	9.5	4.0	15.8	18.4	
CALM	1.2				1.2	.0	
TOTAL	3.5	10.7	52.0	29.9	2.3	100.0	18.0

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 249

HEIGHT (M)	CL	1-1.9	2-2.9	3-3.9	4-5.9	6-7.9	8-9.9	10.9	MEAN	MAX	(DA HR)
% FREQUENCY		4.8	20.0	34.2	29.3	9.5	2.4		2.5M	6.0M	(24 09)

APRIL DATA SUMMARY 8814
AVERAGE LATITUDE 42.0N AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	00.5	(15 12)	06.6	11.1	(30 00)	237	30
SEA TEMP (DEG C)	08.7	(08 15)	09.4	10.6	(29 00)	239	30
AIR-SEA TEMP (DEG C)	-09.6	(15 12)	-00.7	01.2	(30 00)	237	30
PRESSURE (MBAR)	0999.3	(07 06)	1017.9	1037.9	(29 21)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL	MEAN SPEED (KNOTS)	NO. OF OBS: 238
N	.4	9.8	9.7		19.9	11.8	MAX WIND
NE		1.3	2.9		4.2	11.7	SPEED: 29 KNOTS
E	.4	.4	.4		1.3	7.3	DIRECTION: 290 DEG
SE	.4	1.3	5.5	3.8	11.3	18.6	DAY: 05
S	.8	2.5	13.0	9.4	25.7	15.8	HOUR: 21
SW	.4	4.2	8.8		13.4	12.9	
W		1.7	9.2	1.3	12.6	16.0	
NW	.4	4.3	12.2	4.2	25.1	14.5	
CALM	.4				.4	.0	
TOTAL	3.4	21.4	61.9	12.6	.8	100.0	14.9

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 230

HEIGHT (M)	CL	1-1.9	2-2.9	3-3.9	4-5.9	6-7.9	8-9.9	10.9	MEAN	MAX	(DA HR)
% FREQUENCY		1.3	42.8	37.0	13.0	3.9			2.0M	4.3M	(16 00)

MARCH — DATA SUMMARY — 8939

AVERAGE LATITUDE 59.5N — AVERAGE LONGITUDE 141.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-00.8	(29 21)	02.9	06.0	(22 09)	179	30
SEA TEMP (DEG C)	04.3	(21 18)	04.9	05.8	(17 21)	179	30
AIR-SEA TEMP (DEG C)	-03.3	(29 21)	-01.9	01.0	(22 09)	172	30
PRESSURE (MBAR)	0978.3	(18 00)	1007.5	1030.6	(01 21)	174	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

	SPEED (KNOTS)					TOTAL	MEAN SPEED
DIR	4=	11-	22-	34-		%	(KNOTS)
	04	10	21	33	47	347	
N		1.7	.6			2.3	8.1
NE		2.9	1.7	.6		5.2	12.1
E	.6	9.2	10.9	5.8		26.5	15.8
SE	1.7	9.2	9.1	1.7		16.9	12.8
S		1.7	7.5	1.7		11.0	15.3
SW	1.2	2.9	7.0	1.7		12.8	13.0
W		3.5	10.9			20.3	13.6
NW		2.3	.6			2.9	9.0
CALM							
TOTAL	3.5	29.6	59.3	11.6		100.0	13.9

MEAN SPEED: NO. OF OBS: 172

MAX WIND: SPEED: 52 KNOTS; DIRECTION: 180 DEG; DAY: 11; HOUR: 18

APRIL — DATA SUMMARY — 8939

AVERAGE LATITUDE 59.5N — AVERAGE LONGITUDE 141.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	02.5	(19 18)	04.2	07.9	(22 00)	194	29
SEA TEMP (DEG C)	03.9	(19 09)	05.0	07.0	(22 00)	189	29
AIR-SEA TEMP (DEG C)	-03.0	(13 21)	-00.8	02.6	(25 21)	189	29
PRESSURE (MBAR)	0979.4	(14 09)	1007.6	1030.3	(27 18)	190	29

WIND - % FREQUENCIES, MEANS AND EXTREMES

	SPEED (KNOTS)					TOTAL	MEAN SPEED
DIR	4=	11-	22-	34-		%	(KNOTS)
	04	10	21	33	47	347	
N	3.1	2.3	.8			6.2	4.3
NE		2.3	9.3	.8		12.4	12.9
E	1.6	4.7	19.4	8.3		34.1	16.0
SE	.8	.8	11.6	7.3		19.5	15.3
S	2.3	5.9	4.7			10.9	8.2
SW	1.6	3.4	.8	.8		6.5	7.8
W	3.3	9.4	1.6	.8		15.1	8.4
NW	.8	.8	.8			2.3	6.0
CALM							
TOTAL	12.4	25.0	48.8	19.2		100.0	12.8

MEAN SPEED: NO. OF OBS: 129

MAX WIND: SPEED: 59 KNOTS; DIRECTION: 090 DEG; DAY: 14; HOUR: 00

MARCH — DATA SUMMARY — 8934

AVERAGE LATITUDE 40.1N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-09.3	(18 12)	00.6	10.9	(21 21)	240	31
SEA TEMP (DEG C)	05.2	(03 00)	06.3	07.8	(24 21)	240	31
AIR-SEA TEMP (DEG C)	-09.3	(18 12)	-00.8	04.9	(21 21)	240	31
PRESSURE (MBAR)	0985.5	(17 00)	1018.2	1034.7	(12 13)	239	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

	SPEED (KNOTS)					TOTAL	MEAN SPEED
DIR	4=	11-	22-	34-		%	(KNOTS)
	04	10	21	33	47	347	
N		2.9	3.8	.4		6.7	14.2
NE		2.1	3.8	2.1		7.9	15.6
E	.4	4.2	8.8	3.8		17.9	15.9
SE		2.1	2.5	.4		5.0	12.7
S	.8	3.3	4.2	1.7		10.0	13.1
SW		5.0	13.1	5.5		23.4	13.9
W	1.3	3.8	7.9	2.9		19.5	13.0
NW		1.7	6.7	1.3	.4	12.0	19.4
CALM							
TOTAL	2.9	25.0	36.9	17.2	.4	100.0	13.7

MEAN SPEED: NO. OF OBS: 239

MAX WIND: SPEED: 56 KNOTS; DIRECTION: 300 DEG; DAY: 17; HOUR: 06

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING: MODERATE: 1.7% SEVERE: NONE — #OBS: 239

APRIL — DATA SUMMARY — 8934

AVERAGE LATITUDE 40.1N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-01.2	(12 12)	08.8	14.6	(17 21)	234	30
SEA TEMP (DEG C)	06.7	(05 09)	08.4	11.7	(23 21)	233	30
AIR-SEA TEMP (DEG C)	-06.0	(12 12)	00.4	05.4	(17 21)	233	30
PRESSURE (MBAR)	0990.0	(20 06)	1016.8	1026.7	(12 13)	234	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

	SPEED (KNOTS)					TOTAL	MEAN SPEED
DIR	4=	11-	22-	34-		%	(KNOTS)
	04	10	21	33	47	347	
N	.9	3.1	3.9	1.3		9.2	13.9
NE		2.1	2.1	1.3		5.6	14.8
E	.4	1.7	5.6			9.2	10.8
SE		2.1	1.3	.9		4.3	11.4
S	.4	3.3	5.6			9.0	10.1
SW		13.7	14.6			28.3	11.1
W	1.3	12.4	9.4			23.2	10.2
NW		2.1	9.9	6.9		18.9	19.0
CALM	.4					.4	.0
TOTAL	3.4	39.3	46.8	10.3		100.0	12.7

MEAN SPEED: NO. OF OBS: 233

MAX WIND: SPEED: 29 KNOTS; DIRECTION: 300 DEG; DAY: 12; HOUR: 03

MARCH — DATA SUMMARY — 8941

AVERAGE LATITUDE 38.7N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	-00.0	(18 12)	07.1	13.1	(21 18)	242	31
SEA TEMP (DEG C)	08.9	(01 19)	07.2	08.8	(26 21)	243	31
AIR-SEA TEMP (DEG C)	-04.0	(18 12)	-00.1	03.9	(21 18)	242	31
PRESSURE (MBAR)	0987.2	(17 00)	1019.0	1034.0	(23 13)	221	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

	SPEED (KNOTS)					TOTAL	MEAN SPEED
DIR	4=	11-	22-	34-		%	(KNOTS)
	04	10	21	33	47	347	
N	1.3	3.7	3.9	.4		9.3	10.6
NE	.4	3.7	4.1	1.7		10.0	13.9
E	.4	3.8	5.4	1.7		13.3	12.4
SE		1.7	3.8			5.4	12.7
S	.8	2.9	16.2	2.5		22.4	13.6
SW	.4	3.7	10.0	.8		14.9	14.3
W	.8	4.1	5.0	3.7	.8	15.4	16.2
NW	.4	1.7	5.4	2.1		9.5	16.2
CALM	.4					.4	.0
TOTAL	5.0	27.4	53.9	12.9	.8	100.0	14.3

MEAN SPEED: NO. OF OBS: 241

MAX WIND: SPEED: 59 KNOTS; DIRECTION: 290 DEG; DAY: 17; HOUR: 04

WAVES - % FREQUENCIES: MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 248

HEIGHT (M)	CL	1=1.5	2=2.5	3=3.5	4=5.5	6=7.5	8=9.5	10.5	MEAN	MAX	(DA HR)
% FREQUENCY	23.8	48.0	18.5	6.5	3.2				1.5M	5.0M	(10 12)

% OF OBS WITH POTENTIAL SUPERSTRUCTURE ICING: MODERATE: .4% SEVERE: NONE — #OBS: 241

APRIL — DATA SUMMARY — 8941

AVERAGE LATITUDE 38.7N — AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	00.4	(12 19)	10.1	18.0	(17 21)	234	30
SEA TEMP (DEG C)	07.4	(01 00)	09.8	14.3	(18 18)	232	30
AIR-SEA TEMP (DEG C)	-07.7	(12 19)	00.3	08.2	(17 15)	232	30
PRESSURE (MBAR)	0997.2	(26 09)	1016.0	1029.9	(12 13)	234	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

	SPEED (KNOTS)					TOTAL	MEAN SPEED
DIR	4=	11-	22-	34-		%	(KNOTS)
	04	10	21	33	47	347	
N	.9		3.9	2.9		7.7	19.6
NE			1.7			1.7	15.0
E		.4	3.8			3.9	12.1
SE		.4	3.4			3.8	13.0
S	.9	10.8	13.0			24.7	10.9
SW	.4	9.1	12.1			21.6	11.3
W	1.7	5.6	11.9	.4		19.6	11.4
NW	.9	2.6	9.9	4.8		17.7	16.3
CALM							
TOTAL	4.8	29.0	57.1	9.1		100.0	12.9

MEAN SPEED: NO. OF OBS: 231

MAX WIND: SPEED: 30 KNOTS; DIRECTION: 010 DEG; DAY: 09; HOUR: 21

WAVES - % FREQUENCIES: MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 239

HEIGHT (M)	CL	1=1.5	2=2.5	3=3.5	4=5.5	6=7.5	8=9.5	10.5	MEAN	MAX	(DA HR)
% FREQUENCY	41.0	40.2	14.6	2.9	1.3				1.1M	4.3M	(10 09)

MARCH — DATA SUMMARY — 8861

AVERAGE LATITUDE 28.5N — AVERAGE LONGITUDE 090.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	12.8	(17 12)	19.5	23.6	(15 21)	174	30
PRESSURE (MBAR)	1007.2	(09 00)	1017.6	1026.9	(23 13)	176	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

	SPEED (KNOTS)					TOTAL	MEAN SPEED
DIR	4=	11-	22-	34-		%	(KNOTS)
	04	10	21	33	47	347	
N			2.3	1.2		3.5	19.7
NE	1.2	2.3	12.2	1.2		16.9	16.1
E	.6	6.1	10.3			27.0	12.8
SE			27.3	1.7		29.1	15.3
S		1.2	12.8	1.7		15.7	15.4
SW		.6	.6	.6		1.7	13.7
W	.6		.6	.6		1.7	12.7
NW			.6	3.5	2.3	6.4	19.5
CALM							
TOTAL	2.3	10.0	79.6	9.9		100.0	15.1

MEAN SPEED: NO. OF OBS: 172

MAX WIND: SPEED: 59 KNOTS; DIRECTION: 320 DEG; DAY: 18; HOUR: 18

APRIL — DATA SUMMARY — 8861

AVERAGE LATITUDE 28.5N — AVERAGE LONGITUDE 090.9W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	17.0	(01 12)	21.6	26.3	(12 15)	196	30
PRESSURE (MBAR)	1010.6	(06 00)	1018.1	1025.6	(17 19)	196	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

	SPEED (KNOTS)					TOTAL	MEAN SPEED
DIR	4=	11-	22-	34-		%	(KNOTS)
	04	10	21	33	47	347	
N		1.0	3.1	.5		4.7	14.8
NE		2.6	7.3	1.6		11.5	14.9
E	2.6	8.9	11.5	2.6		25.5	13.1
SE	1.6	12.5	14.1	3.6		31.8	12.3
S	2.6	5.7	2.6			10.9	8.0
SW	1.0	2.1				3.6	6.0
W	1.0	4.2				5.2	5.0
NW	.5	1.0	1.6			3.6	8.0
CALM	3.1					3.1	.0
TOTAL	19.0	38.5	40.1	8.3		100.0	11.3

MEAN SPEED: NO. OF OBS: 193

MAX WIND: SPEED: 50 KNOTS; DIRECTION: 110 DEG; DAY: 16; HOUR: 06

Table 6
Selected Gale and Wave Observations, North Atlantic
March and April 1976

Vessel	Nationality	Date	Position of Ship Lat. deg	Long. deg	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb	Temperatures °C Air	Sea	Sea Waves* Period sec.	Sea Waves* Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.*	Swell Waves Height ft.
NORTH ATLANTIC OCEAN		MAR.															
ATLANTICA LIVORNO	GERMAN	4	43.5 N	26.9 W	18	18	44	5 NM	18	1000.0	12.0		7	14.5			
SUGAR ISLANDER	AMERICAN	10	36.2 N	66.3 W	18	25	35	5 NM	09	1004.4	20.5		8	13			
MOBIL LUBE	AMERICAN	10	38.2 N	71.8 W	00	06	45	5 NM	18	1005.1	10.0	11.5	5	13	06	< 6	23
MIRFAK	AMERICAN	10	38.2 N	70.6 W	12	36	H 41	5 NM	50	1003.8	9.2	10.3	3	8	06	10	19.5
STAGHOUND	AMERICAN	12	41.8 N	57.2 W	18	31	50	2 NM		1011.5		12.3	4	13	30	7	23
PRES POLK	AMERICAN	12	39.8 N	61.5 W	12	31	48	2 NM	18	1013.5	5.6	10.3	6	13	31	12	18
SEALAND MARKET	AMERICAN	12	39.2 N	66.9 W	18	21	42	1 NM	64	1008.5	17.3	14.0	7	8	28	7	13
EXPORT LEADER	AMERICAN	12	40.0 N	53.1 W	18	23	48	5 NM	27	1006.4	8.9	14.6	7	14.5	27	7	19.5
LAKE ONTARIO	SWEDISH	12	48.1 N	13.4 W	12	31	50	5 NM	27	998.1	8.5	11.5					
AMER LEGEND	AMERICAN	13	45.6 N	32.6 W	12	25	41	5 NM	01	993.6	11.2	12.2	6	13	25	12	16.5
AMER LEADER	AMERICAN	13	41.3 N	50.8 W	00	30	50	1 NM	62	1009.2	6.3		10	24.5	27	12	23
SEALAND MARKET	AMERICAN	13	38.9 N	48.1 W	00	27	47	5 NM	01	1014.2	12.8	13.9	4	8.5	28	11	19.5
STAGHOUND	AMERICAN	13	40.2 N	65.2 W	18	20	45	2 NM		1008.5		17.8	5	10	29	8	19.5
MERNIA	DANISH	13	41.0 N	33.0 W	18	27	H 55	> 25 NM	01	1011.5	12.0		8	19.5			
LAKE ONTARIO	SWEDISH	13	48.9 N	07.6 W	06	36	50	5 NM	25	999.0	9.5	11.1					
EXPORT LEADER	AMERICAN	13	40.0 N	48.0 W	06	32	48	5 NM	27	1019.0	7.7	17.8	7	14.5	32	8	19.5
AMER LEGEND	AMERICAN	14	45.5 N	35.0 W	06	32	48	1 NM	63	1012.5	7.8	12.5	12	29.5	32	8	19.5
AMER LEADER	AMERICAN	14	40.8 N	62.1 W	12	29	50	10 NM	02	1000.8	10.6	16.7	8	10	29	12	19.5
DOCTOR LYKES	AMERICAN	14	38.0 N	30.0 W	18	28	50	5 NM	25	1008.6	17.3	18.9			28	8	11.5
BERGLJOT	NORWEGIAN	14	38.6 N	18.9 W	12	13	H 55	2 NM		980.0	9.8	7.0	10	14.5	16	12	26
AMER LEGACY	AMERICAN	14	46.0 N	23.5 W	00	20	45	10 NM	05	998.0	10.6	12.8	5	11.5	32	8	14.5
AGUADILLA	AMERICAN	14	34.8 N	74.5 W	00	27	45	2 NM		1005.1	10.2	13.0	6	10	27	8	24.5
EXPORT DEMOCRACY	AMERICAN	14	40.2 N	67.0 W	00	22	45	1 NM	64	992.0	14.5	8.7			31	6	16.5
MOBIL GAS	AMERICAN	14	39.2 N	70.5 W	06	27	50	5 NM	02	1007.1	7.8	12.3	6	10	27	10	19.5
EXPORT AMBASSADOR	AMERICAN	14	37.9 N	69.4 W	12	29	55	5 NM	02	1007.1	14.4	21.2	5	10	28	7	16.5
SEALAND RESOURCE	AMERICAN	14	37.9 N	56.8 W	12	20	48	5 NM	02	1008.0	18.3	16.7	5	8	20	6	19.5
MERNIA	DANISH	14	40.1 N	34.3 W	06	28	H 45	> 25 NM	02	1021.0	12.2		8	19.5			
SEALAND MARKET	AMERICAN	14	38.2 N	39.2 W	12	27	38	2 NM	23	1005.1	19.4	16.1	5	8	24	9	27.5
BERGLJOT	NORWEGIAN	15	36.0 N	29.3 W	18	23	H 55	1 NM	62	976.5	4.0	5.0	8	32.5			
BERGLJOT	NORWEGIAN	16	35.8 N	30.0 W	00	25	H 40	5 NM	89	993.5	2.0	5.0	8	26	24	X	32.5
VALLEY FORGE	AMERICAN	17	38.2 N	73.8 W	06	29	47	10 NM	02	998.5	5.6	12.6	8	19.5			
YOUNG AMERICA	AMERICAN	17	39.5 N	60.3 W	18	28	45	2 NM		994.2	14.3	17.7	6	31			
BIRD	AMERICAN	17	42.2 N	45.2 W	19	20	H 52	.5 NM	07	994.2	8.8	1.7			27	8	16.5
MERIA	SWEDISH	17	37.7 N	58.3 W	18	21	32	2 NM	80	998.5	25.6	19.0	10	19.5			
EXPORT DEFENDER	AMERICAN	17	37.9 N	45.0 W	18	29	48	2 NM	02	1001.4	14.5	19.5	10	32.5			
EXPORT FREEDOM	AMERICAN	17	45.0 N	35.3 W	12	30	45	10 NM	27	1011.2	5.5	12.8	7	11.5	33	9	18
ONE TRANSPORT	LIBERIAN	17	42.3 N	63.5 W	12	26	44	2 NM	11	973.6	3.0	2.5	5	10	28	8	19.5
SAN JUAN	AMERICAN	17	36.3 N	71.7 W	06	29	41	2 NM	07	993.0	11.2	23.4	11	19.5	27	X	32.5
STOLT LION	BRITISH	17	40.5 N	68.3 W	18	27	48	2 NM	15	1002.5	4.0	9.6			27	10	32.5
BALTIMORE TRADER	AMERICAN	17	37.4 N	72.6 W	06	29	40	5 NM	02	999.9	3.3	11.7	6	6.5	29	6	26.5
BERGLJOT	NORWEGIAN	17	32.2 N	37.3 W	06	02	H 55	2 NM	89	994.7	0.7	4.1			33	8	14.5
EXPORT DEFENDER	AMERICAN	18	38.3 N	48.5 W	00	29	45	5 NM	02	1006.8	6.7	17.8	9	8	29	9	26
MOBEA	SWEDISH	18	37.9 N	36.4 W	00	27	45	2 NM	81	1006.2	13.0	17.0	10	16.5			
ONE TRANSPORT	LIBERIAN	18	44.5 N	60.4 W	00	29	41	5 NM	02	993.9	2.0	3.0	3	8	29	9	16.5
AMER LEGEND	AMERICAN	18	41.9 N	63.0 W	00	27	45	2 NM		999.0	5.3	11.2	8	29.5			
BERGLJOT	NORWEGIAN	18	47.6 N	43.0 W	12	23	H 55	2 NM		999.0	4.0	4.0	5	13	23	8	23
LIGHTNING	AMERICAN	20	46.4 N	28.8 W	06	27	50	5 NM	01	1003.0	5.0	11.7	5	13	27	10	19.5
MAMMOTH PINE	LIBERIAN	20	52.7 N	23.9 W	12	30	H 70	< 50 YD	03	973.0	5.1	13.0	5	10	27	12	23
BERGLJOT	NORWEGIAN	20	45.0 N	49.1 W	00	29	H 45	10 NM	85	1022.0	3.0	0.0	3	13	28	8	19.5
LIGHTNING	AMERICAN	21	44.5 N	32.0 W	00	27	45	10 NM	01	1019.6	8.2	12.7	5	10	27	9	16.5
EXXON BANGOR	AMERICAN	23	30.9 N	79.5 W	18	03	H 45	5 NM	03	1024.0	19.5	26.5			02	>13	14.5
BALTIMORE	AMERICAN	23	32.0 N	78.9 W	18	01	42	10 NM	02	1024.7	17.8	28.7	8	14.5	04	X	16
JACKSONVILLE	AMERICAN	24	31.4 N	71.7 W	00	04	45	5 NM	02	1024.3	14.4	24.4	4	11.5	01	7	13
DELAWARE SUN	AMERICAN	24	31.0 N	71.9 W	00	05	45	2 NM	81	1023.4		21.6	8	19			
OCEAN STATION VESSELS																	
ATLANTIC H																	
BUANE	AMERICAN	9	38.0 N	71.0 W	21	08	H 42	1 NM	61	1006.5	9.1	11.5	6	11.5	04	8	8
BUANE	AMERICAN	10	38.0 N	71.0 W	12	02	H 43	2 NM	91	1004.5	8.3	14.5	5	10	08	9	11.5
BUANE	AMERICAN	17	38.0 N	71.0 W	06	29	H 50	1 NM	07	990.7	9.6	14.2	7	14.5	24	8	6.5
GREAT LAKES VESSELS																	
PHILIP R CLARKE	AMERICAN	5	47.8 N	86.1 W	12	05	H 24	< 50 YD	73		- 9.0	2.0		10			
NORTH ATLANTIC OCEAN		APR.															
ATLANTIC CARRIER	LIBERIAN	2	34.7 N	41.3 W	18	14	30	2 NM	91	1015.0	19.9	18.3	8	16.5	12	8	16.5
EXPORT BUILDER	AMERICAN	2	39.0 N	47.6 W	18	12	48	2 NM	15	1016.3	18.3	17.2					
EXPORT BUILDER	AMERICAN	3	39.7 N	36.9 W	18	20	43	2 NM	62	998.6	15.0	18.9			18	6	10
GREEN HARBOUR	AMERICAN	9	37.0 N	70.9 W	18	36	H 45	5 NM	15	1002.7	10.0	12.0	3	11.5	02	8	14.5
MEADOWBROOK	AMERICAN	9	28.4 N	74.4 W	18	36	60	5 NM	25	1001.0	17.2	23.4			36	6	16.5
EDGAR M QUEENY	AMERICAN	9	33.8 N	76.8 W	14	02	42	10 NM	02	1012.2	12.3	20.0	11	23	07	10	18
ELIZABETHPORT	AMERICAN	10	40.7 N	60.2 W	18	22	45	5 NM	02	997.0	19.5	15.0	6	14.5	07	< 6	16.5
MARCONA TRADER	LIBERIAN	10	37.6 N	68.5 W	00	02	45	.5 NM		995.0	13.0	24.0	6	13	02	7	16.5
MECHES	AMERICAN	10	37.2 N	70.7 W	12	35	45	5 NM	02	1011.2	7.8	13.9	5	19.5	X	X	23
SONIC	PANAMANIAN	10	38.2 N	70.8 W	00	03	H 43	1 NM	65	1001.0	7.5	13.0	7	23			
ELIZABETHPORT	AMERICAN	11	40.5 N	62.1 W	06	24	30	5 NM	02	1004.4	11.7	15.7	6	20.5	06	< 6	24.5
AMER LEADER	AMERICAN	11	44.5 N	54.5 W	12	22	45	5 NM	02	1000.0	9.3	4.5	7	19.5			
THOMPSON LYKES	AMERICAN	21	34.7 N	19.3 W	00	27	45	.5 NM	92	1013.2	13.4	10.2	4	6.5	22	6	16
SEALAND VENTURE	AMERICAN	21	43.2 N	21.0 W	18	29	45	2 NM	81	998.0	10.6	13.0	5	6.5	29	6	10
AMER LEGACY	AMERICAN	22	43.5 N	47.5 W	18	32	50	5 NM	09	1009.0	5.9	10.7	5	11.5	32	10	19.5
EXPORT PATRIOT	AMERICAN	22	44.2 N	45.3 W	18	28	40	1 NM	29	997.0	4.3	7.5			28	6	20.5
SEALAND MARKET	AMERICAN	23	42.0 N	33.4 W	12	28	50	10 NM	02	998.9	11.2	10.0	12	32.5	X	X	24.5
EXPORT PATRIOT	AMERICAN	23	43.8 N	45.9 W	06	29	50	1 NM	18	1006.4	7.0	14.5			30	6	20.5
SEALAND MARKET	AMERICAN	25	39.7 N	48.4 W	06	33	45	5 NM	02	1007.0	19.6	12.2	5	6	23	10	19.5
OCEAN STATION VESSELS																	
ATLANTIC H																	
YANKY	AMERICAN	9	38.0 N	71.0 W	21	01	30	2 NM	61	1009.5	9.0	13.5	8	19.5			
YANKY	AMERICAN	10	38.0 N	71.0 W	00	36	52	2 NM	61	1006.5	9.4	12.4	7	19.5			
GREAT LAKES VESSELS																	
JOHN DYKSTRA	AMERICAN	11	43.0 N	83.1 W	06	36	H 42	> 25 NM	02		- 1.0	2.1	7	6.5			

* Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Table 7
Selected Gale and Wave Observations, North Pacific
March and April 1976

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves? Period sec.	Sea Waves? Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH PACIFIC OCEAN		MAR.															
POLAR ALASKA	LIBERIAN	1	43.5 N	133.8 E	06	33	M 45	5 NM	20	996.0	0.5	7.0	5	6.5			
AUSTRAL MOON	AMERICAN	2	41.2 N	151.9 W	18	12	M 62	5 NM	60	1012.5	11.2	8.3	5	8	12	8	11.5
LOMPOC	AMERICAN	2	49.5 N	130.8 W	06	35	50	5 NM	07	1011.5	0.0	5.5	7	11.5			
AUSTRAL MOON	AMERICAN	3	42.2 N	149.3 W	00	14	M 45	5 NM	02	1018.2	11.2	7.8	5	8	09	< 6	6.5
LOMPOC	AMERICAN	4	38.4 N	148.7 W	18	24	45	5 NM	02	1004.7	4.5	2.3	2	8			
CARRETERA	PANAMANIAN	4	34.9 N	169.7 E	18	25	M 46	1 NM	10	999.5	10.0			7	6.5	26	8	14.5
SEALAND EXCHANGE	AMERICAN	5	35.7 N	169.4 E	00	32	45	10 NM	02	1004.7	12.2	13.9	8	23			
JARVIS	AMERICAN	7	56.1 N	167.3 W	00	21	M 45	5 NM	02	986.8	0.8	1.1	9	18			
AMER LEGION	AMERICAN	9	35.9 N	157.8 W	18	36	45	10 NM	03	1023.9	10.0	13.3	4	6.5	36	9	13
PRES JEFFERSON	AMERICAN	9	35.4 N	135.0 W	18	34	47	1 NM	30	1009.1	13.3	15.6	6	11.5	34	9	16.5
SHUNWIND	LIBERIAN	9	45.8 N	154.7 E	12	23	M 30	5 NM	25	1003.5	2.0	2.0					
AMER LEGION	AMERICAN	10	36.1 N	135.9 W	00	20	30	2 NM	07	1011.9	11.7	14.0	4	6.5	02	10	19.5
PACIFIC WING	PANAMANIAN	10	53.3 N	176.6 E	18	23	M 46	.5 NM	18	1012.0	1.0	2.0	6	16.5	23	8	23
PRES JEFFERSON	AMERICAN	10	34.9 N	158.8 W	00	36	50	2 NM	31	1009.5	11.3	14.5	5	14.5	36	7	19.5
EXPORT CHALLENGER	AMERICAN	10	35.5 N	135.3 W	18	02	50	5 NM	07	1010.0	13.5	15.6	3	14.5	03	8	19.5
THOMAS E CUFFE	AMERICAN	11	42.3 N	160.8 W	00	36	45	10 NM	01	1027.8	6.7	10.0	6	8	31	8	13
IBERVILLE	AMERICAN	11	30.7 N	162.2 W	06	31	45	2 NM	62	1010.8	13.4	19.5	6	11.5	31	6	29.5
THOMAS E CUFFE	AMERICAN	12	41.7 N	150.9 W	00	06	45	5 NM	62	1017.3	7.8	11.1	6	11.5	05	8	18
ARCTIC TOKYO	LIBERIAN	12	46.5 N	161.6 E	06	03	M 42	200 YD	75	1007.0	- 1.0	7.0					
YAMASHTN MARU	JAPANESE	12	38.2 N	157.9 W	00	03	M 41	2 NM		1016.5	10.5	13.0	8	13	04	9	23
SHUNWIND	LIBERIAN	12	34.2 N	138.2 E	18	29	M 45	5 NM	07	1005.7	10.2	18.0	4	6	29	8	14.5
ADRIAN MAERSK	DANISH	12	39.6 N	153.3 W	00	05	45	5 NM	02	1012.5	10.5	10.5	7	19.5			
CHEVRON MISSISSIPPI	AMERICAN	12	57.8 N	149.2 W	06	31	45	> 25 NM	02	1014.9	1.1	2.8	3	8	32	8	14.5
VAN FORT	LIBERIAN	13	43.2 N	153.9 E	18	33	M 45	2 NM	51	999.0	1.5	3.0					
V MARTIGAL	PHILIPPINE	13	24.2 N	169.8 E	12	09	M 45	10 NM	21	1017.8	22.5	23.9	3	13			
SHUNWIND	LIBERIAN	13	33.2 N	136.8 E	00	33	M 45	10 NM	01	1013.5	9.2	16.0	5	8	29	8	11.5
EXPORT CHALLENGER	AMERICAN	13	34.3 N	144.9 W	06	14	50	5 NM	62	1018.0	18.2	18.3	3	10	14	8	19.5
VAN FORT	LIBERIAN	14	43.3 N	155.1 E	00	31	M 46	2 NM		1001.5	1.5	4.0					
SEPTA	LIBERIAN	14	43.4 N	166.7 E	00	14	M 48	2 NM	07	1014.5	7.1	5.3	6	13	09	9	14.5
V MARTIGAL	PHILIPPINE	14	25.4 N	171.8 E	00	09	M 45	10 NM	19	1019.8	22.0	21.7	5	13			
RUSE	LIBERIAN	14	26.9 N	156.6 E	12	03	M 44	2 NM	03	1015.0	18.0	21.5					
HUNTIMON	LIBERIAN	14	45.0 N	153.4 E	06	27	M 45	5 NM	03	1005.0	3.0						
RUSE	LIBERIAN	15	26.7 N	159.3 E	00	03	M 41	5 NM	02	1014.5	19.2	21.0					
ASTA ZERRA	LIBERIAN	16	40.1 N	152.1 W	00	31	M 45	5 NM	01		11.0	11.0	10	10	31	>13	16.5
SEALAND MC LEAN	AMERICAN	16	35.6 N	131.1 W	09	32	41	5 NM	18	1005.2	8.9	14.4	8	10	29	8	13
HUNTIMON	LIBERIAN	16	40.1 N	146.3 E	00	28	M 48	5 NM	02	1016.0	7.0						
PRES MCKINLEY	AMERICAN	17	42.8 N	175.0 E	06	14	45	5 NM	02	1000.2	8.3	7.8	5	19.5			
IDAHO STANDARD	AMERICAN	17	51.4 N	130.4 W	05	14	41	5 NM	50	996.5	6.1	8.3	5	6.5	15	9	13
HAKONE MARU	JAPANESE	17	38.7 N	176.9 W	15	12	M 45	1 NM	62	1003.5	11.5	13.0	7	19.5			
SKAGSTAD	NORWEGIAN	19	44.9 N	166.2 W	00	29	47	1 NM	16	998.3	5.1	5.0					
OCTA	LIBERIAN	19	45.9 N	146.4 W	21	27	M 43	5 NM	01	1012.2	6.8	6.0	10	18			
EASTERN HILL	JAPANESE	19	44.8 N	179.0 W	06	26	M 50	2 NM	77	1000.0	3.0	8.0	7	19.5			
OYVI OCEANIC	NORWEGIAN	19	40.4 N	146.8 E	18	27	41	5 NM	02	1000.2	1.0	0.2			27	X	19.5
SEPTA	LIBERIAN	19	44.8 N	152.0 W	06	27	M 45	5 NM	09	1000.2	8.0	9.0	6	10	23	9	13
KASHU MARU	JAPANESE	20	48.4 N	141.5 W	06	27	M 42	2 NM	02	1009.0	5.0	6.0	3	10	26	8	16.5
TUNAMI MARU	JAPANESE	21	46.6 N	142.4 W	18	26	50	.25 NM		996.5	3.0	8.0	6	8	27	10	19.5
ARCO PRUDHOE BAY	AMERICAN	21	50.9 N	139.1 W	06	17	50	2 NM	62	991.2		4.3			17	8	13
SKAGSTAD	NORWEGIAN	21	40.5 N	148.7 W	06	26	50	1 NM	75	988.8	2.6	5.0					
KASHU MARU	JAPANESE	21	53.3 N	152.7 W	18	33	M 45	2 NM	27	1005.0	- 1.0	3.0			34	8	13
ASTA HONESTY	LIBERIAN	21	46.0 N	142.2 W	12	22	M 50	10 NM	88	997.0	5.5	8.0	5	13	25	8	24.5
TUNAMI MARU	JAPANESE	22	46.9 N	142.6 W	00	27	52	.5 NM		1000.0	3.0	8.0	6	10	27	10	29.5
ARCO PRUDHOE BAY	AMERICAN	22	49.6 N	137.4 W	00	22	40	5 NM	02	988.5	5.5	6.7	7	36	26	7	39
MANDARIN VENTURE	LIBERIAN	22	53.9 N	171.8 W	06	10	M 44	200 YD	75	989.8	0.5	2.0	8	14.5	12	11	16.5
ASTA HONESTY	LIBERIAN	22	40.1 N	144.1 W	06	28	M 42	10 NM	01	1008.7	4.0	7.0	8	24.5	28	11	29.5
TUNAMI MARU	JAPANESE	23	47.0 N	147.2 W	06	27	55	.5 NM		1000.3	4.0	8.0	7	10	27	10	29.5
ARCO SAG RIVER	AMERICAN	23	50.0 N	138.0 W	00	27	45	10 NM	02	1000.0	4.5	4.4	4	10	27	8	26
CHEVRON OREGON	AMERICAN	23	35.7 N	121.4 W	12	31	M 47	10 NM	02	1018.2	10.0				31	< 6	11.5
HAWAIIAN CITIZEN	AMERICAN	24	45.4 N	125.3 W	18	27	60	1 NM	18	998.0	8.3	10.0	7	21	27	7	41
PACIFIC WING	PANAMANIAN	24	45.3 N	155.8 W	12	17	M 44	2 NM		1014.5	7.0	6.0	5	8	17	9	11.5
ARCO SAG RIVER	AMERICAN	24	43.5 N	129.0 W	12	32	40	10 NM	02	1000.0	12.0	7.6			27	8	36
VAN CONQUEROR	LIBERIAN	25	50.0 N	152.3 W	18	29	M 45	5 NM	02	1005.0	1.0	3.0					
ALASKAN MAIL	AMERICAN	25	44.7 N	132.7 E	06	29	48	10 NM	26	1018.9	0.6	1.1	8	13			
HAWAIIAN CITIZEN	AMERICAN	25	45.6 N	125.8 W	00	28	45	10 NM	03	1008.9	9.9	10.0	5	13	27	12	32.5
PACIFIC WING	PANAMANIAN	25	45.7 N	142.1 W	18	27	M 44	5 NM	03	1012.2	8.0	7.0	6	10	27	8	14.5
VAN CONQUEROR	LIBERIAN	26	49.9 N	150.2 W	00	29	M 50	5 NM	70	1014.0	9.0	3.0					
BREWSTER	PANAMANIAN	26	53.9 N	144.5 W	00	35	M 42	1 NM	99	990.5	2.0	3.5			36	13	13
SVENDBORG MAERSK	DANISH	27	38.0 N	152.5 E	18	18	45	2 NM	80	996.0	10.5	21.0					
OYVI OCEANIC	NORWEGIAN	27	37.1 N	152.0 E	18	17	45	2 NM	62	1000.0	12.0	18.0		19.5			
BREWSTER	PANAMANIAN	27	54.4 N	153.1 W	00	28	M 42	10 NM	21	995.0	1.5	3.0		6.5	27	8	13
PRES GRANT	AMERICAN	27	33.4 N	145.2 E	12	25	30	200 YD	81	1002.3	16.7	16.7	7	19.5			
KOREA PHOENIX	SINGAPORE	27	45.4 N	179.4 E	18	01	M 50	5 NM	03	1016.0	2.0	8.0	7	10	36	9	13
SEALAND COMMERCE	AMERICAN	27	34.8 N	150.5 E	18	23	60	2 NM	82	996.0	17.3	12.7	6	19.5			
SEALAND FINANCE	AMERICAN	27	40.5 N	152.2 E	18	14	55	1 NM	10	988.8	8.9	7.2			14	11	13
SVENDBORG MAERSK	DANISH	28	38.8 N	155.0 E	00	17	55	1 NM	81	992.0	12.2	14.0					
CAMPBELL	AMERICAN	28	33.9 N	120.7 W	00	34	M 42	10 NM	01	1013.1	11.9	12.2	10	14.5			
OYVI OCEANIC	NORWEGIAN	28	38.6 N	137.1 E	06	25	44	5 NM	02	1000.1	12.0	18.0		19.5			
SEALAND FINANCE	AMERICAN	28	41.1 N	155.1 E	06	16	35	5 NM	02	979.3	5.0	6.1	8	10	16	11	19.5
TRIUMPH	PANAMANIAN	29	48.1 N	159.1 E	18	33	M 43	.5 NM	84	999.6	0.0	3.0	7	19.5			
KOREA PHOENIX	SINGAPORE	29	48.4 N	161.8 W	18	28	M 45	2 NM	26	1030.7	1.0	8.0	6	10	28	7	14.5
PRES FILLMORE	AMERICAN	29	27.8 N	157.7 E	00	36	41	1 NM	62	1013.3	16.7	22.2	3	5			
SEALAND FINANCE	AMERICAN	29	40.9 N	162.8 E	00	24	45	10 NM	02	1000.3	7.2	7.2	5	8	24	9	16.5
ASTA HONESTY	LIBERIAN	29	45.6 N	172.4 E	00	14	M 47	2 NM	50	1015.0	3.0	5.0	6	13	18	10	16.5
TRIUMPH	PANAMANIAN	30	48.9 N	157.9 E	00	29	M 43	2 NM	26	1009.4	2.5	3.0	7	19.5			
SEALAND FINANCE	AMERICAN	30	44.0 N	178.7 E	00	22	45	10 NM	00	1007.1	10.0	4.5	5	6.5	22	8	14.5
CHALMETTE	LIBERIAN	30	35.3 N	148.0 E	18	20	41	2 NM	56	1004.0	17.0	19.0	7	19.5			
BREWSTER	PANAMANIAN	30	54.5 N	177.5 W	06	14	M 44	.25 NM	05	982.0	2.0	2.5					
ALEUTIAN DEVELOPER	AMERICAN	31	52.2 N	170.0 W	12	22	M 70	2 NM	26	996.0	0.0	2.2	6	11.5	18	8	13
ASTA HONESTY	LIBERIAN	31	43.2 N	161.3 E	12	13	M 48	5 NM	03	999.0	9.0	4.0	6	13	18	9	16.5
CHALMETTE	LIBERIAN	31	35.3 N	147.3 E	00	32	41	5 NM	62	1008.0	11.0	13.0	8	16.5			

Vessel	Nationality	Date	Position of Ship		Time GMT	Wind		Visibility n. mi.	Present Weather code	Pressure mb	Temperature °C		Sea Waves*		Swell Waves		
			Lat. deg.	Long. deg.		Dir. 10°	Speed kt				Air	Sea	Period sec.	Height ft.	Dir. 10°	Period sec.°	Height ft.
NORTH PACIFIC OCEAN		MAR.															
BREWSTER	PANAMANIAN	31	53.3 N	173.1 E	12	36 M	41	1 NM	05	1012.0	- 2.0	2.0			36	9	13
TRIUMPH	PANAMANIAN	31	45.8 N	154.0 E	00	03 M	49	1 NM		998.9	- 4.0	2.0	9	19.5	36	9	19.5
NORTH PACIFIC OCEAN		APR.															
CHESHIRE	BRITISH	1	51.2 N	165.8 E	06	32	52	2 NM	79	990.8	0.0	2.0	6	13	33	8	16.5
BREWSTER	PANAMANIAN	1	50.6 N	167.6 E	12	32 M	50	.25 NM	05	990.0	0.0	2.0			32	8	19.5
CHESHIRE	BRITISH	2	49.0 N	164.4 E	00	27	44	5 NM	18	1015.1	3.1	2.0	4	13	29	8	16.5
BREWSTER	PANAMANIAN	2	49.3 N	164.1 E	12	27 M	49	1 NM	05	1021.5	2.0	2.0			27	8	19.5
VAN ENTERPRISE	LIBERIAN	2	48.8 N	179.2 E	06	27 M	48	2 NM	22	1012.0	1.0	3.0	10	16.5	27	10	23
OCTA	LIBERIAN	3	49.1 N	161.8 W	00	27 M	46	.5 NM	64	1000.5	3.5	3.0	13	29.5			
SINCLAIR TEXAS	AMERICAN	3	56.3 N	142.0 W	06	17	45	5 NM	68	992.5	3.3	1.7		21			
CHESHIRE	BRITISH	3	44.6 N	155.1 E	12	21	44	5 NM	02	1004.3	1.5	2.0	4	13			
VAN FORT	LIBERIAN	5	48.8 N	168.5 W	12	33 N	45	5 NM	02	1008.0	3.0	4.0					
ROSE	LIBERIAN	5	34.3 N	138.1 W	06	29 N	41	10 NM	02	1017.6	13.0	16.0					
TRAVIATA	SWEDISH	6	40.1 N	151.2 W	06	27	36	5 NM	02	1003.9	8.0	14.0					
VAN FORT	LIBERIAN	6	48.2 N	176.8 W	20	23 M	45	2 NM	01	987.0	6.0	3.0			23	8	37.5
TAEPING	GERMAN	6	38.7 N	148.2 W	06	29	50	2 NM		1005.0	13.5	13.0	12	36			
PHILLIPS LOUISIANA	LIBERIAN	6	38.1 N	155.5 W	18	34	45	10 NM	02	1026.0	10.0	13.5	6	16.5			
MIDAS ARROW	LIBERIAN	6	52.6 N	173.4 W	18	13 N	42	2 NM	68	990.1	0.0	3.0			14	< 6	13
ROSE	LIBERIAN	6	33.8 N	143.6 W	12	32 N	44	1 NM	07	1006.5	15.0	17.0					
SPERO	NORWEGIAN	6	38.7 N	150.4 W	12	29	48	5 NM	81	1009.3	9.7	11.0		16.5	29	X	19.5
MIEI MARU	JAPANESE	6	36.0 N	147.0 W	12	30 N	47	2 NM	81	1007.5	9.5	14.0	6	16.5	30	9	19.5
EXXON NEWARK	AMERICAN	6	46.1 N	130.7 W	18	12	43	10 NM	03	999.5	10.0	7.7			12	< 6	13
VAN ENTERPRISE	LIBERIAN	7	43.5 N	144.8 W	00	33 N	42	5 NM	02	1008.0	7.0	7.0	9	16.5	33	>13	19.5
VAN FORT	LIBERIAN	7	48.0 N	177.1 W	00	26 N	42	2 NM	02	994.0	3.5	3.0					
TAEPING	GERMAN	7	35.5 N	143.0 W	00	32	49	10 NM	02	1007.0	17.2	13.0	9	29.5	28	8	24.5
JARVIS	AMERICAN	7	52.9 N	166.4 W	15	23 N	42	2 NM	07	974.2	2.3	2.2	12	19.5			
HAWAIIAN CITIZEN	AMERICAN	7	32.0 N	146.7 W	00	32	42	10 NM	02	1016.8	17.2	20.6	6	8	32	12	19.5
EXXON NEWARK	AMERICAN	7	45.1 N	129.6 W	00	14	43	2 NM		998.0		7.7			14	< 6	13
CRESSIDA	PANAMANIAN	7	52.8 N	173.0 W	12	29 N	50	1 NM	73	983.0	2.0	3.0	8	24.5	29	>13	26
MIDAS ARROW	LIBERIAN	7	52.5 N	176.7 W	06	30 N	52	1 NM	25	985.2	0.5	3.0	6	13	27	>13	29.5
LEA	LIBERIAN	7	47.5 N	174.0 W	00	24 N	45	5 NM	01	1000.0	4.5	4.5	6	16	24	9	29.5
PACGLORY	LIBERIAN	7	34.4 N	146.5 W	06	11	45	.5 NM	73	982.0	2.0	2.0	X	11.5	11	12	21
KINYO MARU	JAPANESE	7	53.8 N	174.0 W	18	32 N	46	2 NM	07	991.5	0.5	3.0	3	6.5	30	9	16.5
PACIFIC BEAR	AMERICAN	7	53.5 N	178.8 W	18	27	50	5 NM	02	1000.3	0.5	2.7	6	11.5	30	11	16.5
PHILLIPS LOUISIANA	LIBERIAN	7	38.2 N	154.0 W	00	34	42	10 NM	02	1026.5	14.5	12.2	6	16.5			
PACKING	LIBERIAN	7	53.7 N	179.9 E	00	34 N	45	.5 NM	72	986.0	0.0	4.0	X	10	34	>13	29.5
ZEALAND VENTURE	LIBERIAN	8	42.1 N	149.7 E	00	28 N	53	.25 NM	80	983.0	4.3	4.0	8	13	28	9	24
SHUNWIND	LIBERIAN	8	43.1 N	170.0 E	06	13 N	45	200 YD	61	988.0	5.0	6.0	5	13	13	10	21
PACIFIC WING	PANAMANIAN	8	48.0 N	159.2 E	00	09 N	32	< 30 YD	86	992.0	0.5	1.0	8	14.5	09	X	24.5
KRONOLAND	SWEDISH	8	33.8 N	163.2 E	00	27	44	5 NM	50	1006.2	20.5	17.0	6	13	24	12	10
NORSE PILOT	BRITISH	8	32.8 N	136.3 W	00	31 N	32	10 NM	15	1010.0	14.9	9.0	6	13	33	>13	41
KINYO MARU	JAPANESE	8	53.6 N	174.8 W	00	33 N	50	.25 NM	74	1000.5	0.0	2.5	5	11.5	30	8	21
PACGLORY	LIBERIAN	8	34.3 N	171.4 W	00	32	45	.5 NM	10	992.0	- 1.0	2.0	10	13	30	12	19.5
PACIFIC BEAR	AMERICAN	8	53.3 N	179.9 E	00	31 N	45	5 NM	70	1010.5	0.0	2.2	9	19.5	27	12	19.5
CRESSIDA	PANAMANIAN	8	52.5 N	176.6 W	00	29 N	50	5 NM	71	1003.0	0.0	1.2	9	26			
GOLDEN RAY	LIBERIAN	8	53.5 N	162.4 W	18	28 N	43	.5 NM		995.0	1.2	3.5	10	29.5			
CAMPBELL	AMERICAN	9	42.7 N	124.9 W	18	18 N	46	10 NM	02	1007.6	10.0	10.5	8	6.5	21	9	8
VAN FORT	LIBERIAN	9	44.7 N	171.2 E	12	22 N	45	5 NM	89	991.5	5.0	4.0					
PACIFIC BEAR	AMERICAN	9	51.0 N	166.5 E	06	08 N	30	1 NM	74	982.0	0.0	2.5	10	41			
OCTA	LIBERIAN	9	39.1 N	166.3 E	03	26 N	46	5 NM	02	1010.2	11.2	11.0	14	23			
INDIAN MAIL	AMERICAN	9	42.8 N	166.3 E	12	29	35	10 NM	02	995.3	9.9	9.3	5	16.5	29	9	41
MIDAS ARROW	LIBERIAN	10	52.4 N	176.0 E	06	05 N	43	.5 NM	68	987.8	- 1.0	3.0	5	14.5	22	>13	26
PRES JEFFERSON	AMERICAN	10	48.4 N	127.7 W	00	13	42	5 NM	60	1001.7	8.9	6.7	5	11.5	13	13	13
INDIAN MAIL	AMERICAN	10	42.7 N	165.3 E	00	29	35	10 NM	02	1007.1	6.1	9.3	3	10	29	11	44
VAN FORT	LIBERIAN	14	35.1 N	141.4 E	18	01 N	46	2 NM	61	1003.0	13.5	10.0					
JAPAN BEAR	AMERICAN	14	37.8 N	124.5 W	12	36 N	42	10 NM	03	1013.2	9.4	9.4	4	10	32	7	14.5
GOLDEN RAY	LIBERIAN	14	43.1 N	151.1 E	12	17 N	42	30 YD		1001.2	7.0	2.0	6	10			
IDAHO STANDARD	AMERICAN	14	59.2 N	152.0 W	19	32	30	5 NM	03	1008.0	- 3.3	3.0			32	< 6	10
PORTLAND	AMERICAN	15	55.0 N	142.8 W	00	29	48	5 NM	05	1008.5	3.9	4.4	10	6.5	29	12	16.5
PHILADELPHIA	AMERICAN	15	52.2 N	138.2 W	18	32	40	5 NM	01	1013.5	6.7	7.8	4	16.5	29	8	41
PRINCESS DIAMOND	PANAMANIAN	15	49.2 N	138.0 W	00	30 N	49	5 NM	03	1019.0	4.0	7.0	4	10	31	7	23
PRES TAFT	AMERICAN	15	48.8 N	143.1 W	00	31	42	10 NM	03	1026.0	7.8	4.4	7	11.5			
IRISH ELM	IRISH	15	33.8 N	154.3 E	06	21	32	1 NM	19	1006.7	19.0	16.7	8	29.5	20	12	32.9
PRES TAFT	AMERICAN	16	52.8 N	157.2 W	12	27	30	2 NM	31	987.6	2.2	0.1					
IDAHO STANDARD	AMERICAN	16	57.4 N	150.2 W	19	09	48	5 NM	02	985.0	2.8	5.0	4	8	X	X	19.5
SOUTHWELL	AMERICAN	16	56.2 N	153.7 W	09	07 N	47	.5 NM	71	984.5	1.0	3.3					
SEALIFT PACIFIC	AMERICAN	16	51.6 N	152.1 W	18	25	45	5 NM	23	988.8	2.8	1.6	3	8	25	8	46
SEALIFT PACIFIC	AMERICAN	17	51.6 N	153.7 W	00	27	47	10 NM	02	1002.4	5.0	1.7	3	8	27	9	41
SEALIFT PACIFIC	AMERICAN	18	52.3 N	162.8 W	06	23	42	10 NM	23	992.2	1.6	1.1	3	8	27	8	19.5
ASIA BRAVERY	LIBERIAN	19	46.3 N	139.1 E	12	27 N	45	1 NM		998.5	1.0	3.0			27	10	29.5
PRES TAFT	AMERICAN	20	47.1 N	163.9 E	00	29	42	5 NM	83	998.0	2.8	0.0	8	19.5			
KOREA PHOENIX	SINGAPORE	22	30.1 N	148.9 E	06	30 N	45	2 NM		1009.7	21.0	21.0	4	6.5	18	6	6.5
MARGRETHE MAERSK	DANISH	23	39.9 N	147.2 W	18	33	45	10 NM	81	1024.0	10.4	12.0					
PEARL VENTURE	LIBERIAN	23	53.4 N	146.2 W	06	03	42	2 NM	60	990.0	2.0	4.0	4	8	03	8	13
THOMAS E CUFFE	AMERICAN	24	44.6 N	179.4 E	12	34	45	10 NM	02	1020.7	4.4	3.5	5	8	32	9	19.5
EATON GLORIA	LIBERIAN	25	47.2 N	138.2 W	00	11 N	30	1 NM	10	1009.3	8.0	5.0	6	10			
THOMAS E CUFFE	AMERICAN	25	49.7 N	170.4 W	12	35	45	10 NM	02	1020.3	3.3	7.8	3	8	33	9	19.5
TUYOTA MARU #12	JAPANESE	25	33.5 N	139.1 W	06	19 N	42	.5 NM		1011.7	17.0	16.3	6	6.5	16	9	13
TRIUMPH	PANAMANIAN	25	49.0 N	161.5 W	12	03 N	44	2 NM	05	998.6	3.0	6.0	9	31	03	>13	31
VANGUARD	LIBERIAN	25	37.8 N	168.3 W	06	32 N	45	5 NM	81	1013.0	9.0	14.0	15	29.5			
EATON GLORIA	LIBERIAN	26	47.9 N	145.1 W	18	15 N	35	1 NM	10	1006.0	6.0	5.0			18	< 6	14.5
J H TUTTLE	AMERICAN	27	59.4 N	143.0 W	06	11	30	2 NM	44	1015.4	3.0	3.0	4	11.5	10	9	19.5
EATON GLORIA	LIBERIAN	27	47.9 N	143.5 W	00	16 N	45	1 NM	10	1013.0	7.0	5.0	5	11.5			
GOLDEN RAY	LIBERIAN	30	41.0 N	162.3 E	18	28 N	41	5 NM	02	1004.0	7.0	9.5	5	10	27	12	10
AUSTRAL MOON	AMERICAN	30	46.6 N	135.4 W	06	14 N	44	10 NM	01	1001.9	8.4	5.0	6	11.5			

* Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

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on the 30th, a ship reported 40-kn winds south of the 992-mb center, which was near 46°N, 153°E. Later in the day, the HOYO MARU had gales with 20-ft swells.

The storm was traveling almost due eastward and passed the LOUIS L.D. leaving 40-kn winds behind and 20-ft seas. On May 2, the storm took on a northerly component in its path. The STAR BILLABONG, near 47°N, 161°W, had 50-kn winds on the starboard side. To the south, along the front, a ship radioed a 45-kn report from 36°N, 166°W. At 1200, the storm's pressure was 965 mb, and the GEH YUNG, at 45°N, 159°W, had 23-ft swells.

On May 5 the storm was 977 mb near 50°N, 168°W. Gales were blowing south of the center. Two ships reported 23-ft swells. On the 7th, the storm disappeared in the Gulf of Alaska.

Tropical Cyclones, Western Pacific--Marie and Nancy were the April tropical cyclones. Marie reached typhoon strength while Nancy remained a tropical storm. Marie developed southeast of Yap on the 3d. She moved on a typical parabolic path, recurving near 10°N, 130°E. During the northward part of this recurvature, she reached peak intensity. From the 9th through the 12th, winds near her center exceeded 100 kn; they reached 115 kn on the 11th. On the 12th, the accelerating and weakening storm crossed the 20th parallel near 132°E. Marie continued to weaken as she skirted Honshu 2 days later. She was the first April storm to do so in 20 yr.

Nancy formed near Eniwetok Island on the 25th. She moved west-northwestward as a minimal tropical storm from the 26th to May 1. On May 1 Nancy passed within 100 mi of Saipan and turned toward the southwest. The following day she was just a weak depression.

Casualties--Thick fog over the Inland Sea and the Pacific resulted in two collisions on the 22d. The 3.5-ton fishing boat TOKURYO MARU and the 9,053-ton ferryboat SUZURAN MARU collided, and the fishing boat sank with the two fishermen rescued. The 2,850-ton freighter GYOSEI MARU and the 197-ton fishing boat TAIYU MARU also collided with damage to both vessels.

The BARGE 419 in tow by the tug SEA MONARCH broke adrift during gale-force winds, on the 27th, and stranded stern first on Montague Island, Alaska. After being refloated, the barge was towed to Cordova by the tug WARRIOR and then to Seattle by the SEA MONARCH. The 8,159-ton GOLDEN LEADER ran aground in fog near 33.1°N, 128.7°E, on the 29th, broke in two, and sank. The crew was rescued.

Rough Log, North Atlantic Weather

June and July 1976

ROUGH LOG, JUNE 1976--There were major differences from climatology in the paths of the storm centers this month. According to climatology, the primary tracks are: Over Lake Superior to the Gulf of St. Lawrence, Lake Winnipeg across southern Hudson Bay where it splits toward the Davis Strait and the Labrador Sea, Cape Cod to Belle Isle then toward the Faeroe Islands, and from about 180 mi southeast of Kap Farvel to northwestern Iceland.

This month the primary paths were concentrated between Lake Superior and Lake Winnipeg to James Bay. Only three centers survived to reach the sea as they crossed Quebec. A primary path moved southeastward from Ungava Bay to the vicinity of 50°N, 35°W, where it curved sharply northward toward Iceland. Another originated west of Nova Scotia, moved eastward to midocean, and then northeastward toward the Faeroe Islands. No major cyclone center crossed the United Kingdom or the European continent to the south. Only one small cyclone occurred over the Mediterranean Sea.

The sea-level pressure pattern helps explain the behavior of the cyclone centers. The normal pressure pattern indicates two weak 1009-mb Lows along 60°N at 35°W and 60°W. The Bermuda-Azores High at 1024 mb is centered near 32°N, 35°W, with ridging into the southeastern United States and into western Europe.

This month the Icelandic Low had one 1001-mb center near 60°N, 30°W. The High was 1025 mb at 30°N, 50°W, with a 1024-mb subcenter near 40°N, 20°W, and another 1023-mb subcenter near 48°N, 05°W. These differences resulted in higher pressures over western Europe and the eastern United States.

The anomaly centers reflect the differences described above. There was a minus 9-mb center near 58°N, 30°W. There were plus 5-mb centers near 36°N, 60°W, and the English Channel. The high pressure over northwestern Europe brought high temperatures and dry weather. Many areas suffered drought conditions.

The 700-mb upper-air pattern corresponded with the surface. An anomalous Low was centered near 59°N, 37°W, and a closed High was near 30°N, 51°W. There was more ridging than normal over the eastern United States and a very pronounced ridge over western Europe.

There were no tropical cyclones this month. On the average one will occur every 2 yr.

Extratropical Cyclones--There was only one severe storm this month, and it occurred during the middle of the month. Most of the cyclones were weak, generating only minimal gales or less.

The first storm of any significance formed as a frontal wave over Maine on the 1st. The first gales were reported on the 2d. The FEDERAL SCHELDE at 48.7°N, 44.2°W, encountered 43-kn gales, and the DART AMERICA at 44.3°N, 54.9°W, braved 40 kn.

At 1200 on the 3d, the 983-mb LOW was at 57.5°N,

35°W. Ocean Weather Station Charlie measured 38-kn winds at 0600, and by 1800 the swells had increased to 20 ft. Early on the 4th, the LOW was moving northward toward the Denmark Strait. The NANOK S. was south of Iceland with 44-kn winds, and the SOMERSET MAUGHAM was north of the Island with the same winds. At 1800 a trio of Icelandic fishing vessels all reported 37 kn north of the Island. At that time the LOW was stationary off Keflavik and dissipated on the 5th.

This was one of the few storms that originated far inland and survived to menace shipping. It was first analyzed east of Lake Winnipeg at 1200 on the 10th and raced eastward as a frontal wave. When it moved over Newfoundland and the water at 1200 on the 11th, it started deepening rapidly. At 1800 the UZHS at 51.5°N, 37.7°W, had 40-kn southeasterly winds. By 1200 on the 12th, the 972-mb storm was near 59°N, 30°W. Ocean Weather Station Charlie was riding out 36-kn winds and 18-ft seas, while the KIMOVSK at 53°N, 26.8°W, enjoyed 40-kn southerly winds and 15-ft seas. At 1800 the QUEENSGARTH at 53.7°N, 30.4°W, had 46-kn winds and 20-ft seas.

On the 13th the 980-mb LOW was passing south of Iceland, and Ocean Weather Station Lima was pounded by 40-kn winds and 23-ft swells. On the 15th the storm moved inland over Norway, having traveled shore to shore.

Monster of the Month--This was the next frontal wave on the cold front that produced the storm described above. At 0000 on the 12th, it was over Maine. Only 35-kn gales were found. It deepened from 992 mb at 0000 on the 13th to 977 mb by 1200 near 47°N, 49°W (fig. 28). At 0000 on the 13th, the CETRA COLUMBA (39.5°N, 46.5°W) fought 56-kn winds from the southwest. Two

other ships in that area reported gales in the 40-kn category. At 1200 the report from the CETRA COLUMBA indicated a devastating 90 kn. A SHIP, about 300 mi southwest of the center, was sailing into 30-ft swells. A ship north of the center which may have been the ORE METEOR rolled with 40-kn winds and 20-ft seas. At 1800 the ETROG at 45.1°N, 55.2°W, contended with 50-kn winds and 16-ft waves.

At 0000 on the 14th, the LOW was 970 mb near 50°N, 42°W, and the NEW ENGLAND HUNTER at 43°N, 47°W, was mauled by 70-kn winds and 33-ft waves. The ORE METEOR at 50°N, 50°W, was plowing into 55-kn winds, 23-ft seas, and 26-ft swells. At 1200 the POST RUNNER near 44°N, 39°W, wallowed in 60-kn winds, 20-ft seas, and 30-ft swells. Winds of 40 kn and seas of 20 ft were reported by several ships. The GUNTHER SCHULTE had 44-kn winds and 16-ft waves at 1800.

One of the biggest factors of this storm was the high seas, especially for an extratropical summer storm. At 0000 on the 15th, Ocean Weather Station Charlie hosted 26-ft seas with 40-kn winds, and a ship near 53°N, 43°W, had 23-ft seas. North of

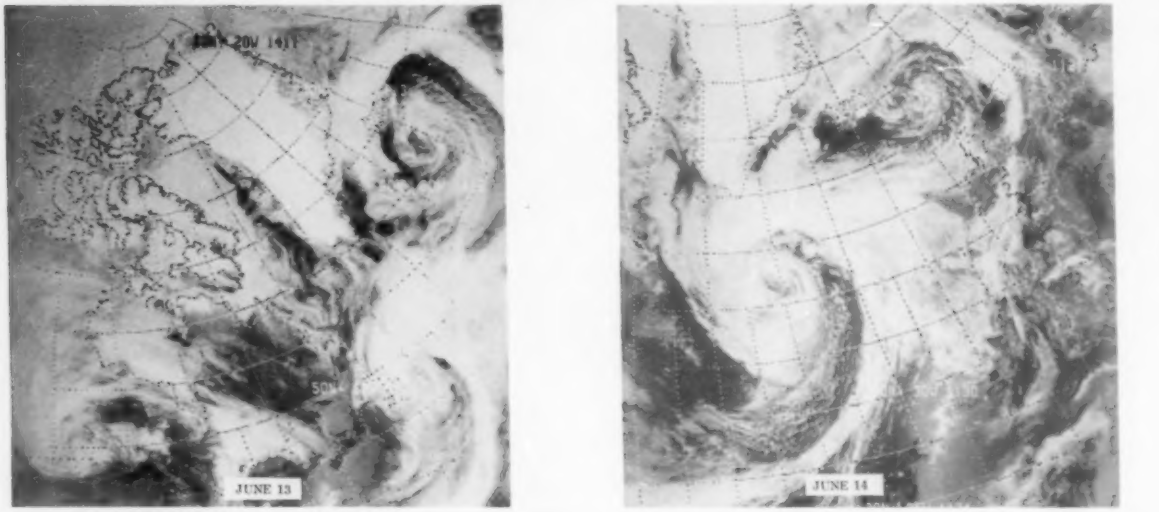

Figure 28.--At 1421 on the 13th, the Monster is centered near 48°N, 50°W. The storm west of Kap Farvel is not near as strong, but has a more classical appearance. At 1127 on the 14th, the two storms have reversed appearances.

the center, the MISIGSSUT (60.3°N, 42.2°W) had 52-kn northerly winds. Near 50.7°N, 33.2°W, the DLHO also had 52-kn winds, but from the southwest, and by 1200 they had increased to 60 kn. The C.P. TRADER at 51°N, 40°W, was sailing with 40-kn winds, 20-ft seas, and 26-ft swells.

On the 16th the storm was weakening and curving eastward. Late on the 17th it disappeared from the analysis.

Many of the 125 yachts in the singlehanded yacht race from Plymouth, England, to Newport, R.I., which started June 5 were probably involved in this storm. As of July 15, all but 7 had been heard from, 48 had finished, 43 had retired from the competition, and 34 (including the 7) were still to arrive at Newport.

This low-pressure system and storm lasted from the 12th to the 28th. It originated over North Dakota and moved northward over Manitoba where it turned eastward. It then moved eastward across Canada as a fairly strong storm. On the 17th it crossed the Labrador coast with a large circulation, but part of it broke off on the 18th and moved up the Davis Strait as the LOW passed south of Kap Farvel. The storm almost dissipated on the 20th as it made a cyclonic loop during the 20th, 21st, and 22d. During this time, the highest winds plotted were in the minimal gale category.

On the 22d and 23d, another LOW came off the Labrador coast and moved around the southern periphery of the LOW. There was one report of 35-kn gales.

On the 0000 chart of the 24th, the second LOW had been absorbed into the circulation of the original LOW. Ocean Weather Station Lima measured 40-kn winds and 20-ft seas. At 0600 a buoy at 61.8°N, 29.1°W, reported 39-kn northerly winds. At 1200 Lima was still battling 20-ft waves, and the NANOK S. had 52-kn winds out of the south.

On the 25th the 981-mb storm moved over Iceland into the Norwegian Sea. It was gradually weakening and disappeared over the Barents Sea on the 28th.

Casualties--The tug SALLY L. capsized and sank in the Houston Ship Channel during a storm on the 1st. The 9,171-ton POINTE NOIRE touched the bank of the St. Lawrence Seaway in fog early on the 4th.

The barge NEPCO 140 carrying 6 million gal of oil struck a fog-shrouded Comfort Island in the Thousand Island area of the St. Lawrence Seaway. It was estimated that 250,000 gal of oil were spilled into the river.

ROUGH LOG, JULY 1976--The Atlantic was relatively quiet as would be expected in a summer month. The number of cyclone tracks was near normal, but diffuse. The tracks off the U.S. East Coast were more easterly than the normal northeasterly. Over the north-central ocean south of Greenland and Iceland, most storms had a definite tendency to curve northward then northwestward. There was one cyclone over the Mediterranean Sea, and the few that affected Europe did nothing to alleviate the drought.

The mean sea-level pressure pattern for the month was nearly identical to the climatological normal, except for two shallow Lows (1010 mb) which were missing over Iceland and Norway. The normal shows three shallow Lows--a 1008 mb over Cape Chidley and the two mentioned above. The Cape Chidley Low was 1008 mb, but was west of Angava Bay. The normal closed High was centered over the Greenland ice cap. The Bermuda-Azores High was 1024 mb versus 1025 mb, and it was centered at 30°N, 40°W, slightly south of its climatological position.

There were many minor anomaly centers over the Atlantic portion of the hemisphere. The largest was a plus 4 mb off Bergen, Norway. There were two minus 3-mb centers, one near the Bay of Fundy and the other over the Azores Islands.

The upper-air pattern over the eastern United States and western Atlantic differed from climatology only in that the usual trough over the coast was more sharp. A minor ridge extended southward from the North Sea with the usual slight trough along longitude 10°W displaced to 20°W. The significant anomaly was plus 55 m over the North Sea.

The first tropical cyclone of the season, tropical storm Anna, was named about midday on the 30th.

Extratropical Cyclones--This LOW formed in a sharp trough associated with a north-south oriented front and was first analyzed on the 0000 chart of the 3d. At 1800 on the 2d, the DART AMERICA was west of the front at 44.2°N, 36°W, with 48-kn northerly winds. At 0000 on the 3d, PYATIDES KOMSOMOLA was near the front at 38.5°N, 28.9°W, with 40-kn westerly winds. At 1200, the 1003-mb frontal wave was near 51°N, 25°W. The DART AMERICA was traveling eastward at about the same speed as the front and had 40-kn gales. The waves were 10 ft. Far back to the west behind the same front and over the Gulf Stream, a SHIP reported 50-kn winds near 40.5°N, 69.5°W. The report contained only the position and wind, and the wind may have been associated with a thunderstorm.

On the 4th, the 1002-mb center was moving northward with only light winds. At 1200 on the 5th, the LOW was southwest of OWS Lima. The USDL (49.3°N, 11°W) reported 40-kn south-southwesterly winds. Early on the 6th, a LOW moving eastward, south of Kap Farvel, absorbed the circulation.

This frontal wave was first analyzed near Asheville, N.C., the home of the National Climatic Center, where its history will be preserved long after it is gone. The time may also have been significant--0000 on July 4. Twenty-four hours later, it was over the Gulf Stream, moving eastward at 1009 mb, causing no fireworks. At 0000 on the 6th, the WELSH CITY reported a thunderstorm near 37°N, 53°W. The frontal wave was racing under the influence of a short wave aloft. At 1800 the JAPAN CEDAR (41.7°N, 39.7°W) reported 35-kn winds, 15-ft seas, and 20-ft swells. By 1200 on the 7th, the 1007-mb wave was at 46°N, 25°W (fig. 29). South of the front at 39.2°N, 35.2°W, the PACDUCHESS had 52-kn southwesterly winds. The AMERICAN ALLIANCE was at 35.2°N, 30.2°W, with 40-kn winds during a thunderstorm.

On the 8th, the storm developed a larger circulation as it turned northward. At 1200 it was near 52.5°N, 15°W. At 0000 on the 9th, Valentia, Erie,

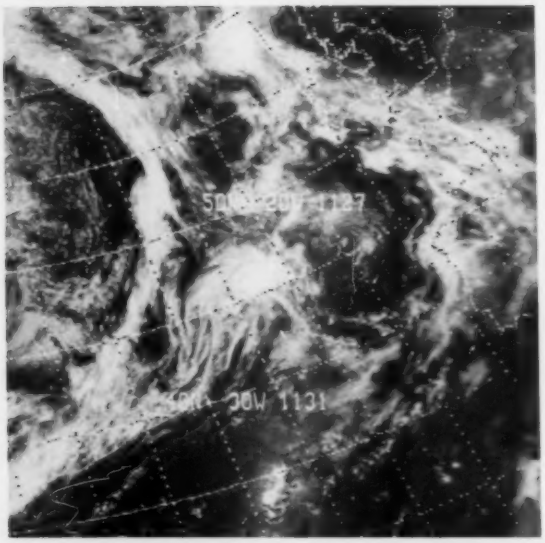

Figure 29.--This image shows the storm at 1128 GMT. The bright spot near 46°N, 23°W, is probably an area of thunderstorms.

on Dingle Bay measured 50-kn winds. On the 10th, the LOW was absorbed by another.

The Labrador Sea was the mother of this storm. It was first analyzed on the 1800 chart of the 7th and moved southeastward then eastward before turning northward on the 9th. It remained an open wave for most of this time. On the 9th, it passed around the edge of the previous storm and was the one that absorbed it. At 1200 the CAST BEAVER (52.5°N, 19.4°W) had intermittent heavy rain and 44-kn winds. At 1800 the PORYV, at 50°N, 27.7°W, had 40-kn westerlies. The LOW deepened rapidly on the 10th and 11th, and it was 978 mb at 0000 on the 11th near 57°N, 22°W. Ocean Weather Station Lima measured 16-ft seas and swells. At this time, the LOW became nearly stationary under an upper-air LOW near 56°N, 25°W (fig. 30), until the 15th when a short wave moved through the upper-air circulation, and the 700-mb LOW retrograded westward.

This report of high swells was connected with a long period of southwesterly flow between the Bermuda-Azores HIGH and various LOWs moving northeastward, northwest of the HIGH. Winds of 20 to 30 kn were the general rule. The seas and swells varied from 5 to 15 ft. At 0000 on the 14th, the NEDLLOYD DEJIMA found 8-ft seas and 23-ft swells at 37.6°N, 52°W, and the SEA-LAND ECONOMY found 16-ft seas and 8-ft swells near 31.5°N, 57°W.

A northerly-oriented trough developed out of the Saharan heat LOW over Algeria late on the 18th over western Iberia. A 1014-mb LOW had formed over Lisboa by the 0000 chart of the 20th. At 1200 the LEOPOLD, at 40°N, 11.4°W, experienced 40-kn winds. The small LOW remained stationary, and at 1200 on the 21st, the MUIRFIELD found 37-kn winds near the

Figure 30.--From high above, the storm looks like a huge whirlpool, which it probably resembles as much as anything else.

same spot (40°N, 12.4°W). At 1800 the BUKAVU, at 42.2°N, 09.8°W, was also hit by 40-kn gales. On the 22d, no closed LOW could be analyzed.

There was a complex frontal system over the north-

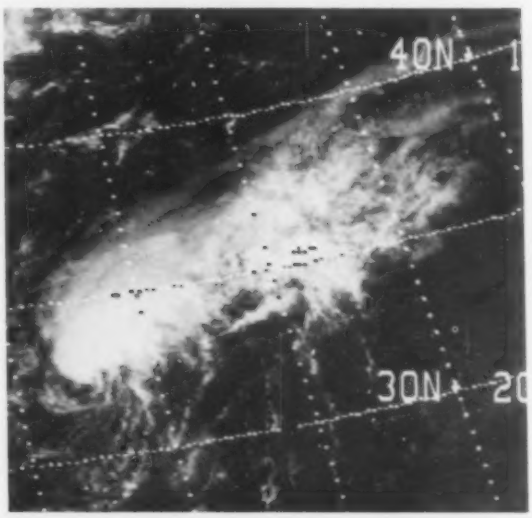

Figure 31.--Anna is not well organized with no distinct center near 33°N, 31°W. The Azores are about 400 mi to the north-northeast.

eastern United States on the 23d and 24th which was slowly sliding south and eastward. On the 1200 chart of the 24th, what appeared to be a new LOW developed north of Maine. This LOW deepened rapidly as it moved over the Gulf of St. Lawrence, and the fronts consolidated. At 1200 on the 25th, the JOHN CABOT (44.2°N, 57.9°W) reported 39-kn gales, the SEA-LAND GALLOWAY (41.4°N, 59.9°W) had 35-kn winds with 15-ft waves, and another ship reported 40 kn with a thunderstorm near 36°N, 65°W.

On the 26th, the LOW remained stationary north of Anticosti Island with the front continuing to move eastward. Early on the 27th, it disappeared.

Tropical Cyclones--Anna was named the season's first tropical cyclone on the 30th. She developed from a Low that had formed some 1,000 mi east-southeast of Bermuda. This is an unusual location for tropical cyclone development. On the 30th, she was located at 30.7°N, 38.5°W, or about 775 mi southwest of the Azores. Carrying minimal tropical storm winds, she was moving east-northeastward at about 20 kn. Maximum winds increased to 30 to 40 kn early the next day, and it looked like Anna would pose a threat to the Azores (fig. 31). However, before the day was through, she weakened considerably, bypassing 150 mi south of Santa Maria.

Casualties--A 94-ft yacht, the THUNDERBIRD, sank in 200 ft of water in Lake Michigan on the 11th. The $1 million, 1-yr-old vessel was battered by strong winds and heavy seas. On the 12th, the 19,160-ton RALPH MISENER reported damage during a squall off Indiana Harbor on Lake Michigan. The Greek-registered 8,957-ton AEGIS FORCE arrived Havana with machinery damage resulting from bad weather.

Rough Log, North Pacific Weather

June and July 1976

ROUGH LOG, JUNE 1976--There were vast differences between the climatological and actual storm tracks and pressure pattern this month. Climatology shows a primary storm path with a nearly constant northeasterly orientation from Japan to the northern Gulf of Alaska. Another primary path enters the Gulf of Alaska from a more southerly direction. A secondary path crosses the northern Kuril Islands and stretches eastward to the Andreanof Islands where it turns northeastward to the Kuskokwim Bay of Alaska.

This month the paths of the centers of the LOWs were very diffuse. There were also many short-lived LOWs (less than 30 hr) which do not show on the track chart. The path of most concentration stretched from northern Honshu eastward to the vicinity of 40°N, 175°W, where some dissipated while others loitered and turned northward toward the Bering Sea. One moved into the Gulf of Alaska. A few LOWs entered the Gulf of Alaska from the southwest. Two LOWs entered the Bering Sea from the west.

The pressure pattern was as different from climatology as the storm tracks. Normally, the primary Low is slightly north of Adak Island at 1010 mb. A 1011-mb Low is over the Alaska Range. The Pacific High at 1024 mb is near 33°N, 146°W, and bulges westward, being the most dominant feature. The High was still the dominant feature at 1027 mb near 37°N, 144°W, but it was more circular. Only a tongue of high pressure bulged westward between 20° and 30°N. The primary Low was 1011 mb centered near 41°N, 178°W. The pressure gradient over the western half of the ocean was very flat.

The anomaly chart was significant because of the positive centers over the northern ocean and the large negative center over the central ocean. A minus 4-mb center was near 38°N, 176°W. There were two plus 5-mb centers, one over Bristol Bay and the other to the southeast near 50°N, 150°W.

The upper-air pattern at 700 mb more closely resembled the climatological pattern. The primary Low was centered over the southern Bering Sea with two closed High cells centered near the center of each half of the ocean. A sharper-than-normal trough stretched southward along the 178°W meridian. Weak troughs paralleled both coasts.

Typhoons Ruby and Sally both formed late in the month. Hurricanes Annette and Bonny occurred over the eastern ocean.

Extratropical Cyclones--This was one of the LOWs that formed over Japan, near Nagoya, and tracked eastward to the central ocean. It was first detected on the 1200 chart of the 2d, on a front that paralleled the south coast of Honshu. At 0600 on the 3d, the SEIUN MARU, at 36°N, 146°E, found 45-kn northerly winds after the center passed to the east of her position. At 1200 the circulation was growing in size, but not in intensity.

On the 4th, a weak HIGH following the LOW started building and expanding. The LOW was being squeezed between the HIGH and a small HIGH to the east, and it gradually broke down to a frontal wave again. Late on the 6th, it could no longer be identified from the data.

There was only one really significant wind with this storm, but it was one of the higher ones for the month. The storm spent much of its life in a data-sparse area. It formed on the 2d, near 37°N, 171°E, and moved east-northeastward. On the 3d, it turned southeastward with a fairly large circulation and a central pressure of 998 mb. On the 4th, it developed into a cutoff LOW; by the 6th, the 1002-mb center had circled clockwise to 28°N, 169°W, prior to turning northward again. The winds were light with 25 to 30 kn the maximum, but, on the 8th, the KAIWO MARU

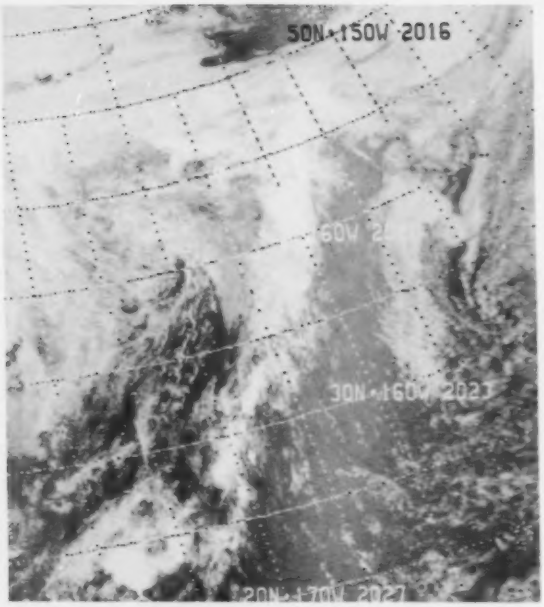

Figure 32.--The satellite passed over the storm at about 2020 on the 9th. The surface center of the storm was near 43°N, 174°W. The front had moved eastward through the circulation and can be seen east of the storm's center.

had 16-ft swells on the west side near 36°N, 179°E. As the LOW moved northward, a front moved southeastward and was picked up in the circulation.

A HIGH to the north and another to the east were blocking any rapid movement of the LOW. As the cold front moved eastward against the HIGH, the MARITIME DOMINION was surprised by 55-kn southerly winds ahead of the front, at 0000 on the 9th, at 34.6°N, 163.5°W (fig. 32). The storm was moving due north as the blocking HIGH retreated into the Bering Sea and weakened fast. On the 11th, the LOW turned westward and disappeared on the 12th.

This LOW moved off the coast of China on the 4th and moved along the north coast of Japan on the 5th. At 1200 the KOLJUGEV reported 38-kn southerly winds off the Tsugaru Strait. At 0000 on the 6th, the LOW had split into two centers, one on each side of Honshu (fig. 33). The 1002-mb center off the east shore was the stronger and the one that survived. This tightened the gradient on the east side of the LOW, and five vessels reported winds of 40 to 45 kn. The PACIFIC WIND, at 36°N, 146°E, reported the highest of 45 kn and 13-ft seas. Others were the KIKUWA MARU, POST CHARGER, and VAN TRIUMPH.

The LOW was moving on a northeasterly track along the Kuril Trench as the HIGH blocked easterly movement. At 0600 on the 7th, the ARISTEUS was southwest of the center near 40°N, 149°E, with 44-kn westerly winds. At 1800 the PRIVIV was bounced by 38-kn winds and 15-ft seas near 36°N, 160°E. There were no gale-force or higher winds reported on the

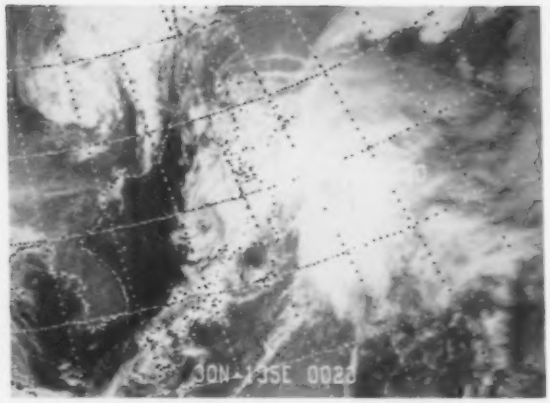

Figure 33.--The two centers are near 39°N, 137°E, and 36°N, 144°E, at 0021 on the 6th.

8th and 9th, and the LOW could no longer be identified by the 10th.

This frontal wave developed south of Tokyo on the 1200 chart of the 13th. By 0000 on the 15th, the LOW was 994 mb near 37°N, 150°E. The MARITIME DOMINION was nearing Japan as she approached the storm and encountered 46-kn gales. Six hours later, at 34.9°N, 152.9°E, she was fighting 56-kn southwesterly winds. At 0000 on the 16th, a ship with the call letters JAYT had 38-kn winds and 23-ft seas west of the center. Other ships were reporting 16- to 18-ft seas and swells. At 1200 the central pressure was 990 mb. On the 17th, the IRISH MAPLE and SHOWA MARU both labored with gales.

Between 0000 and 1200 on the 18th, the LOW filled 10 mb as it passed south of a LOW over the western Bering Sea. A ship near the other LOW had 45-kn winds. On the 19th, the LOW was gone.

On the 13th, a front stretched from Taiwan to 160°W, across nearly three quarters of the Pacific like a tightrope. There were four vibrations along the rope--frontal waves. One near 170°E was to amplify as it moved eastward, but not until the 15th. At 1200 it was near 44°N, 167°E, at 990 mb. At 1800 the PRESIDENT VAN BUREN, at 43.2°N, 161.6°W, encountered 38-kn winds. The winds around this storm were not especially high, but high swells were measured. At 0000 on the 16th (fig. 34), a ship whose code appeared to be the NOPAL LANE was swept by 41-ft swells near 42°N, 154°W. About 200 mi to the northwest, near 43°N, 159°W, another ship was treated to 20-ft seas and 25-ft swells. Far to the south, near 35°N, 170°W, the MARITIME RELIANCE suffered with 26-ft swells.

There were no more reports of extreme waves, but as the LOW stalled off Kodiak Island on the 18th, the JAMSONS encountered 40-kn gales from the westsouthwest, south of the center. Before the day was over, so was the storm.

This closed cyclonic circulation was first analyzed on the 0000 chart of the 23d, around the point of occlusion of a frontal system. The CHIBA was about 200 mi

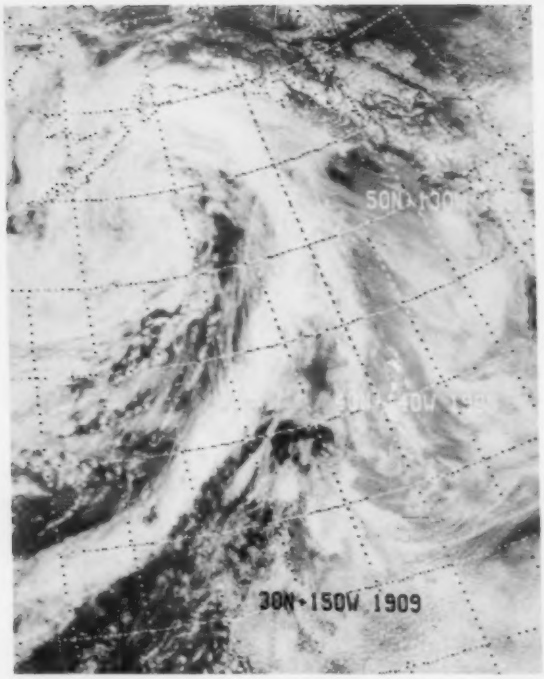

Figure 34.--The high waves encountered with this storm were 600 to 900 mi south of the center.

east of the center, near 38°N, 174°E, with 40-kn gales. At 0000 on the 24th, the 1002-mb LOW was near 39°N, 177°E. The ALASKAN MAIL was at 38°N, 174°W, with 40-kn southeasterly gales. At 0000 on the 25th (fig. 35), there were three 40-kn reports north and west of the center by the AKADEMIK SHIRSHOV, SANKO-STAR, and SINCERE No. 5. At 0600 the DAIHO MARU (43°N, 179°E) was blown by 45-kn gales and tossed by 16-ft seas. By 0000 on the 26th, the 981-mb LOW had moved to 41°N, 175°W. North of the center, at 45°N, 179°E, the SHINYU MARU was sailing into 40-kn gales, 20-ft seas, and 30-ft swells. The DAIHO MARU, not far away at 43°N, 178°W, had 38 kn and 20-ft waves.

Late on the 26th, the LOW had three centers as one moved in from the west and another developed on the front. At 0000 on the 27th, the ALASKAN MAIL was sailing westward with 60-kn northerly winds. At 0000 on the 28th, the MINETAMA MARU was 300 mi north of the LOW (984 mb) with 40-kn gales and 16-ft swells. Late on the 29th, the original LOW dissipated, and one of the new LOWs became the major circulation.

Tropical Cyclones, Eastern Pacific--June is usually considered the beginning of the eastern Pacific tropical cyclone season. Sure enough, the first depression was sighted on the 3d near 11°N, 95°W. Three days later, Annette was christened as the first tropical storm, and within 24 hr she became a hurricane. After an apparent initial indecision, Annette established a west-northwesterly track. She intensified rapidly. Maximum winds exceeded 100 kn from the 8th through the 11th. On the 9th at 1200, the 29,720-ton Norwegian bulkcarrier THORUNN encountered very rough swells in 35-kn winds nearly 200 mi northeast of the storm's center. Six hours later, a 60-kn wind came in from a ship 180 mi to the northeast of Annette's center. The hurricane reached a peak on the 10th (fig. 36) when winds near her center were estimated at 120 kn with gusts to 135 kn. Early in the day, the KISO MARU, a Japanese fishing trawler, reported 35-kn winds some 100 mi south of the center. Late on the 11th, Annette passed within 100 mi of Socorro, which reported a 40-kn wind from the east.

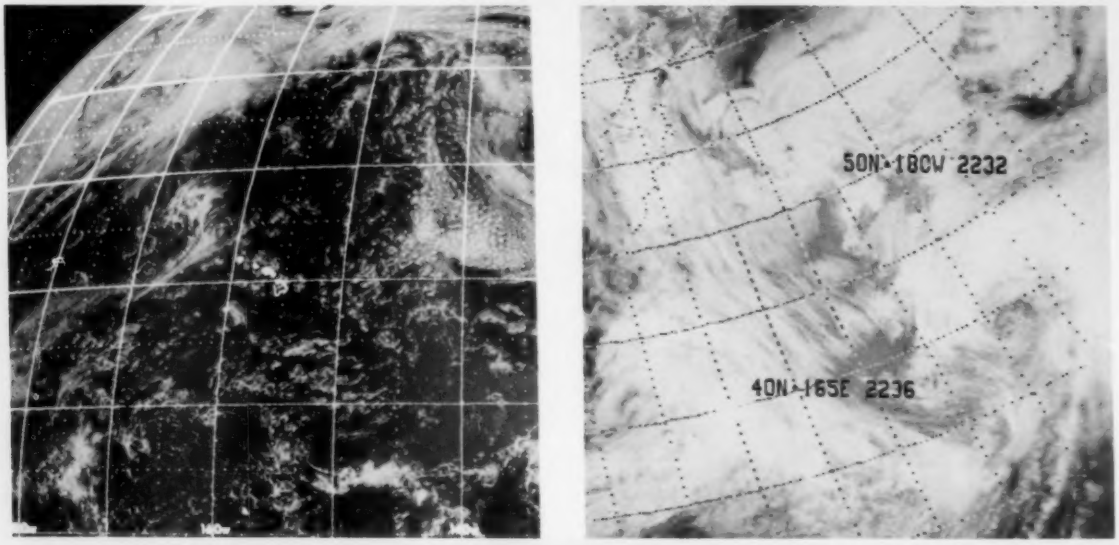

Figure 35.--These pictures show the storm (39°N, 178°W) from two different perspectives. The SMS-2 (left) shows the storm from an oblique angle, while the NOAA-4 looks nearly directly down on it.

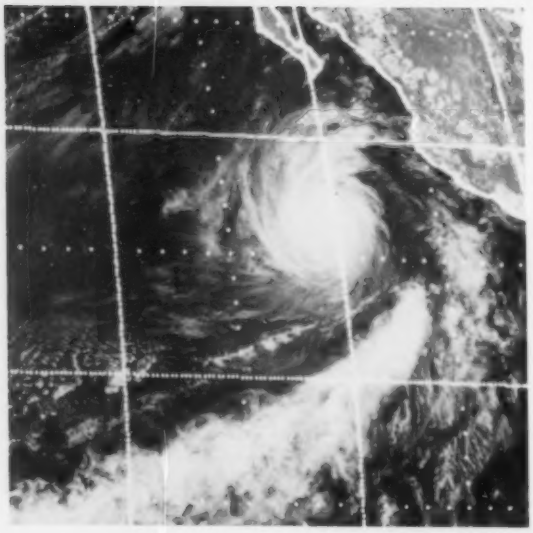

Figure 36.--Hurricane Annette, on the 10th, with 120-kn winds and gusts to 135 kn.

By the 14th, she was a weakening depression approaching 20°N, 115°W.

The beginning of hurricane Bonny turned up in the satellite photos on the 26th. She was just 180 mi south of Manzanillo. The suspense of whether she would head for land was quickly ended when she established a definite westward track. Bonny became a tropical storm late on the 26th; she was a hurricane 24 hr later by the time she crossed the 110th meridian near 17°N. At about this time a ship close to her center reported 50-kn winds in 6- to 8-ft seas. Her peak winds (65 kn) were only minimum hurricane intensity (fig. 37). Socorro reported only 20-kn winds

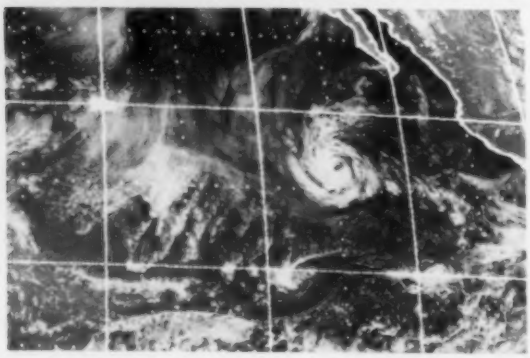

Figure 37.--Bonny reached hurricane strength on the 27th, but she was not as severe as Annette as the satellite images indicate.

as Bonny passed 80 mi to the south. By the 29th, she was a weakening depression as attested to by the 20-kn winds reported from near her center by the ATLANTIC STAR.

Tropical Cyclones, Western Pacific--Ruby and Sally formed in late June within 1 day of each other. They moved on parallel paths with Sally developing to the east. Ruby formed east of Samar in the Philippine Sea on the 23d. One day later, Sally was detected about 250 mi south of Guam. The twins moved northwestward for 4 days before recurving to the northeast. Ruby's path took her across Luzon as a typhoon. This overland journey slowed her development. Sally, travelling the friendly Pacific waters, intensified steadily. Both storms recurved at 20°N--Sally near 132°E on the 28th, and Ruby near 116°E on the 27th. On the 28th, the MEIHO MARU encountered 18-ft swells in 45-kn winds, 120 mi east of Sally's center. Near her center winds had peaked at 110 kn. Another ship 150 mi to the south-southeast was reporting 24-ft swells and 18-ft seas. By the 28th, Ruby had recurved through the Luzon Strait and was reintensifying. On the 30th (fig. 38), the TAKAO SAN MARU

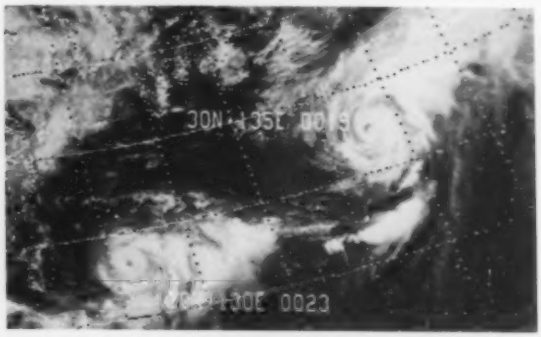

Figure 38.--By the 30th, typhoon twins Ruby (left) and Sally are heading toward the northeast.

reported 40-kn winds 120 mi to the south-southwest of Ruby's center. Ruby reached her 110-kn peak on the 2d as she moved east of the Ryukyu Islands. Ruby was weakening and became extratropical although her winds remained intense as she crossed the 35th parallel near 150°E.

By 0000 on the 4th, Sally was extratropical. The ASIA MOMO, near 41°N, 174°E, reported fighting 55-kn winds and 33-ft swells. The PAN ASIA was within 100 mi of the 970-mb storm center with 40-kn winds and 16-ft waves. The ORIENT PINE was 200 mi to the northwest with 60-kn winds and 16-ft seas. The PRESIDENT MADISON was 180 mi south of the center

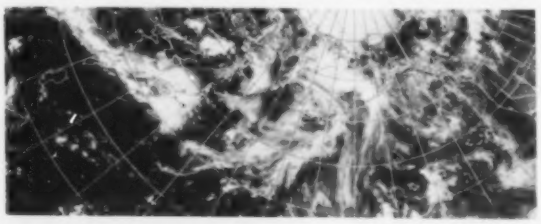

Figure 39.--This view of extratropical Sally (50°N, 173°E) is from a Northern Hemisphere composite of satellite orbits. The cloud conditions between Taiwan and California can be seen in one image.

with 40-kn gales. At 0600 the BREWSTER was ravaged by 70-kn winds. Seas as high as 23 ft were reported. At 1200 four ships reported gale-force winds and waves up to 16 ft. At 0000 on the 5th, the 978-mb storm was near 50°N, 173°E (fig. 39), and the BREWSTER, about 300 mi south of the center, noted 60-kn winds with 20-ft seas and 33-ft swells.

After tracking northward, the storm suddenly turned eastward, on the 5th, leaving a few gale reports along its path.

Casualties--The 10,205-ton Iranian ARYA AKHTAR sustained two periods of heavy weather during which the cargo broke adrift while on loaded passage from San Francisco to Singapore.

ROUGH LOG, JULY 1976--The general trend of the storm tracks this month was more easterly than long-term climatology indicates, except in the Gulf of Alaska area. A climatic secondary track across Sakhalin Island into the Bering Sea was a primary track this month. The normal climatic path originating near Japan was approximately 5° latitude farther south and traced a path easterly toward the Gulf of Alaska, rather than northeasterly into the Bering Sea.

The predominant pressure feature was the Pacific High at 1026 mb, centered near 33°N, 165°W. The climatic location is normally 39°N, 150°W, at 1025 mb. There were two anomalous low-pressure centers, a 1006 mb near 54°N, 179°E, and a 1012 mb near 52°N, 142°W. The climatic mean pressure pattern does not indicate a low-pressure center over the North Pacific. A 1010-mb center is almost directly over the North Pole, and there is a large cyclonic circulation over the Asian Continent.

There were two significant negative anomaly centers, both 7 mb, near 55°N, 177°W, and 50°N, 140°W. There was an irregular area of positive anomaly approximately 10° latitude wide that stretched from the Yellow Sea to 30°N, 160°W.

The primary feature of the 700-mb pressure height chart was the zonal flow between latitudes 40° and 50°N. The mean Pacific High was higher than normal, and the anomalous surface LOWs were reflected in an anomalous LOW at 700 mb over the central Bering Sea. The primary mean cyclonic circulation center was still over the Arctic Ocean.

There were eight tropical cyclones over the North Pacific, four for each hemisphere. Over the eastern ocean there were three tropical storms (Celeste, Estelle, and Fernanda) and hurricane Diana. Over the western ocean there were typhoons Therese and Anita and tropical storms Violet and Wilda.

Extratropical Cyclones--The extratropical part of typhoon Sally, which originated in June and extended into July, would have to be the "Monster of the Month." This LOW originated near 48°N, 177°E, northeast of typhoon Sally on the 2d. By 1200 on the 4th, the LOW was 994 mb near 48°N, 150°W. The PAPYRUS MARU, at 40.9°N, 151.4°W, had 32-kn gales and 13-ft waves. Twelve hours later, the CHEVRON FRANKFURT reported 35 kn near 38°N, 153°W. Late on the 5th, the storm turned northward and on the 6th westward. At 0600 winds of 40 kn were radioed by the ORIENTAL AMIGA near 48°N, 126°W, and the SUN BOWL also had 40-kn gales near 54°N, 147°W. At 1200 the PRESIDENT MADISON found 40-kn winds and 12-ft seas near 43°N, 147°W.

Late on the 7th, the storm again turned eastward, and the UGOU was hit by 44-kn gales. On the 8th, the BREWSTER reported 40-kn winds twice on her eastern course. On the 8th, the storm curved northward again, only to turn back toward the south on the 9th, and dissipate on the 10th.

This storm formed over the Kuril Islands, east of a LOW that had moved out of Manchuria, in an area of weak gradient on the 12th. A warm front extended eastward to another LOW over the Aleutian Islands. At 1200 it was 1002 mb near 51°N, 160°E. At 0000 on the 13th, the JAMSONS was at 45.7°N, 163.8°E, with 44-kn gales. At 0000 on the 14th (fig. 40), the VULCAN, near 48°N, 172°E, received 40-kn gales at frontal passage, and a ship identified only as URI was on the receiving end of 46-kn winds near 53°N, 159°E. At this time, the LOW was about 996 mb near 54°N, 165°E. The LOW was moving eastward very slowly and started filling. By the 18th, it no longer existed.

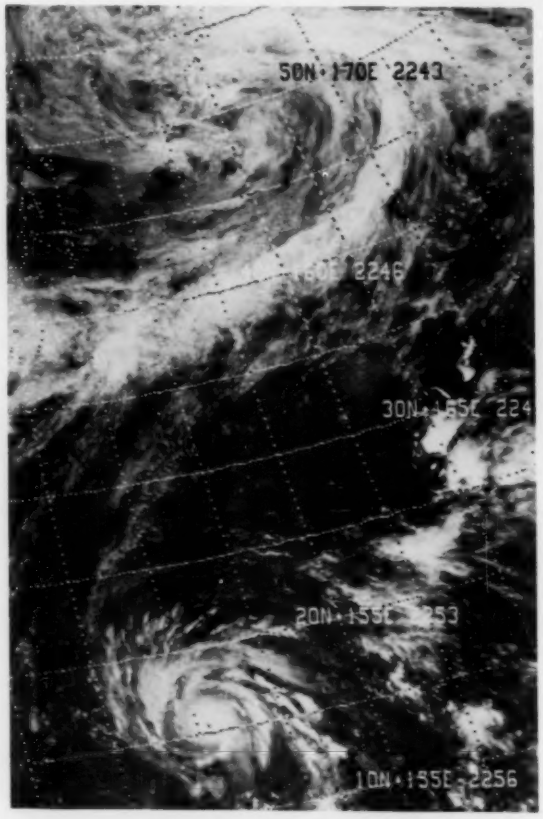

Figure 40.--The surface LOW cannot be detected owing to high-level clouds. Cloud streaks can be seen stretching south from the front to typhoon Therese.

This LOW started as a frontal wave, late on the 14th, south of another LOW over the Gulf of Alaska. It rapidly became the major system. A ship found 40-kn gales near 47.5°N, 139°W. By 0000 on the 16th, it was 992 mb near 53°N, 142°W. The GYOKUYO MARU was south of the center with 40-kn gales. Other ships were reporting 10-ft seas. At 0000 on the 17th, the LOW was 998 mb, and the pressure had risen to 1014 mb by 0000 on the 18th.

This was one of the long-lived circulations. It started as a frontal wave east of Tokyo near 147°E. It moved generally eastward as a 1016-mb wave. It managed to survive cutting off a segment of the Pacific High and moved into the eastward flow on the 22d. By the 23d, it was still only 1004 mb near 49°N, 164°W.

At 0000 on the 24th, the J. E. GOSLINE was southwest of the center, near 43°N, 158°W, with 45-kn westerly winds, but only 8-ft waves. At 0600 the JUNEAU MARU was north of the center with 35-kn easterly winds. At 1200 on the 25th, the LOW was 1002 mb near 54°N, 144°W. At 1800 the HILLYER BROWN, near 51.5°N, 138°W, had 35-kn gales and 13-ft swells. At 0000 on the 26th, the LOW was weakening, but the GRAND CARRIER, near 49°N, 140°W, managed 35-kn gales. By the 27th, the LOW had broken up on the coast.

This was the deepest extratropical storm to affect the North Pacific this month. It started over the Tatar Strait on the 24th. When it moved over the Kuril Trench on the 25th, it started deepening. At 1200 on the 26th, it was 982 mb, near 54°N, 174°E, but the winds were still in the 20-kn category. At 0000 on the 27th, the pressure had dropped to 978 mb, and now the KONSANTIN PAUSTOVSKI, near 53°N, 173°E, had 45-kn winds and 16-ft seas. A ship east of the center and north of the Aleutians reported heavy rain and 16-ft swells.

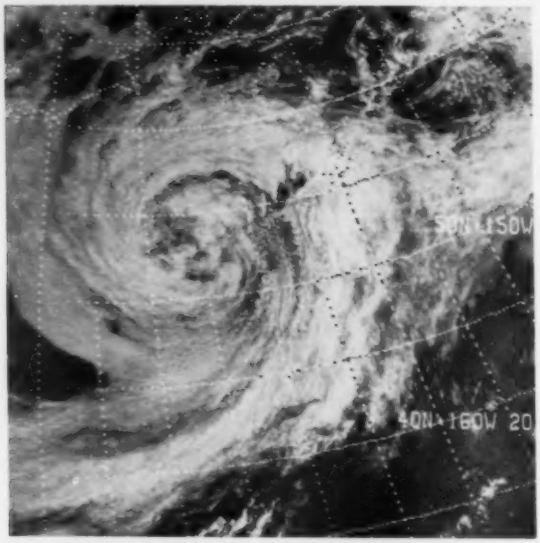

Figure 41.--This large, deep storm covers the Bering Sea and most of the major shipping lanes between Alaska and Japan.

At 1200 on the 27th, the LOW was at its lowest pressure of 976 mb near 53.5°N, 177°W (fig. 41). Its cyclonic circulation stretched from the Bering Strait south to near 35°N. At 0000 on the 28th, the LENINETS was about 300 mi southwest of the center with 40-kn winds and 20-ft seas. In the southeast quadrant, near 51°N, 168°W, a Japanese ship reported 16-ft seas and 20-ft swells.

At this time, the LOW was headed northward over the Bering Sea and filling. At 0000 on the 29th, the TIRASPOL (55°N, 167°W) contended with 34-kn winds and 13-ft seas. By the 30th, the LOW had deteriorated to only a trough.

Tropical Cyclones, Eastern Pacific--Celeste and Diana developed within 1 day and 450 mi of each other. Both formed near 11°N--Celeste at 108°W on the 14th, and Diana at about 102°W a day later. Celeste took a westward track and became a tropical storm. Diana moved west-northwestward and reached hurricane strength. Celeste's winds reached 45 kn on the 16th, while Diana (fig. 42) attained an 80-kn peak on the 19th. Both peaks occurred at about 120°W about 250 mi apart. While Diana was reaching her peak, Celeste was dissipating as she crossed the 140th meridian near 13°N. When Diana reached that same meridian, near 19°N on the 22d, she was also on the wane.

Toward the end of the month, two weak tropical storms flared briefly in the eastern Pacific. Both developed at about 12°N and moved west-northwestward. Estelle formed near 122°W on the 26th, while Fernanda was found about 700 mi farther west on the 28th. It appears that maximum winds in neither storm climbed above 35 kn. Both lasted as depressions through August 1; Fernanda moved within 200 mi of the Hawaiian Islands.

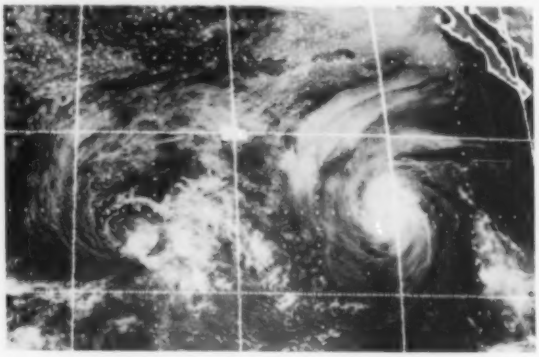

Figure 42.--Diana close to peak intensity on the 18th, as Celeste peters out farther to the west.

Tropical Cyclones, Western Pacific--Therese developed rapidly. She reached typhoon strength, on the 12th, about 150 mi north of Truk and was a supertyphoon the following day. For a while she threatened Guam, which was still recovering from the blow dealt by supertyphoon Pamela in May. However, Therese turned northwestward and brought her fury to Saipan instead. Winds near her center were estimated at 135

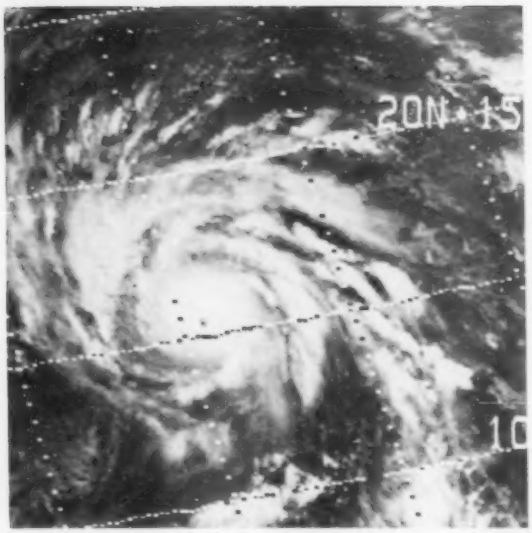

Figure 43.--Supertyphoon Therese covers Saipan late on the 13th.

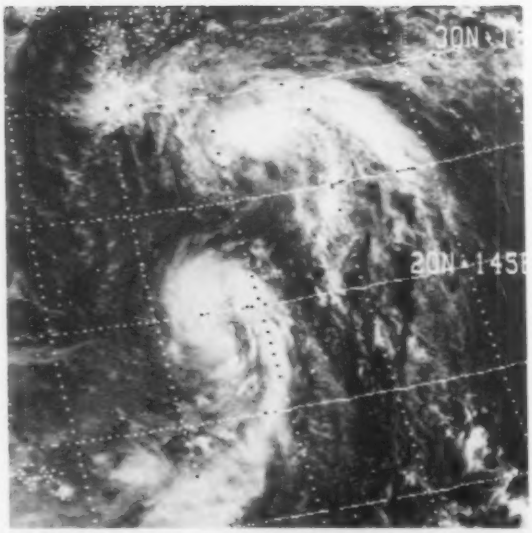

Figure 44.--Wilda approaches Japan late on the 22d, as Anita gets it together to the south.

kn on the 13th (fig. 43). Although her intensity diminished somewhat on the 14th, Therese remained potent as she moved northwestward toward the Ryukyu Islands. On the 15th, the JESSIE STOVE, 150 mi west of her center, encountered 45-kn winds. Minami-daito jima reported 50-kn winds on the 17th as Therese moved through the central Ryukyu's. Winds were still at typhoon strength when Therese made landfall on the 19th over western Kyushu near Sasebo.

Less than one week later, tropical storm Wilda and typhoon Anita came ashore on the eastern side of Kyushu. Wilda developed near 20°N, 137.5°E, on the 22d, while Anita was spotted near 19°N, 134°E (fig. 44. They both moved in a northerly direction. Early on the 23d, Wilda's winds peaked at about 50 kn, while Anita briefly attained typhoon strength late in the day. Both were tropical storms when they moved across eastern Kyushu, Wilda late on the 23d and Anita about 24 hr later.

While Japan was suffering from this flurry of activity, tropical storm Violet was on the loose in the East China Sea. She developed on the 21st near 15°N, 116°E. Violet headed northwestward and encountered Hainan before her winds could climb above 55 kn (fig. 45). On the 24th, the tropical storm moved northeastward back out to sea. Carrying winds of 40 kn, Violet moved over mainland China near Yang chiang on the 25th.

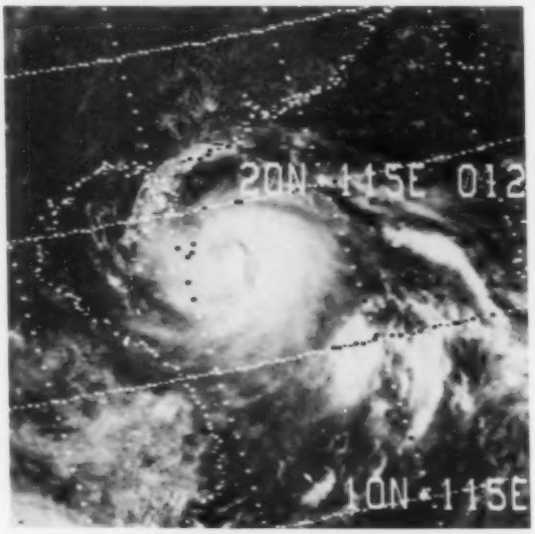

Figure 45.--Violet on a collision course with Hainan early on the 23d.

Casualties--During the early morning of the 8th, the 977-ton ORENJI MARU and the 498-ton NAGATO MARU No. 31 collided in heavy fog on the Inland Sea. The 23,486-ton AUSTRALIAN EXPORTER reported damage to a crane during a storm on July 10. A hovercraft reported to be traveling at 50 mi/h across Beppu Bay in fog collided with the 200-ton bulkcarrier KOSEI MARU on the 14th. Twenty-five persons were injured. The hovercraft capsized, but all escaped.

On the 18th, the DIAMOND M. NUGGETT, a drilling rig, lost its anchor during strong winds at Salvador and grounded.

Marine Weather Diary

NORTH ATLANTIC, OCTOBER

WEATHER. Storms in the middle and higher latitudes increase in frequency and energy during October. The westerlies have pushed southward, and the 1002-mb Icelandic Low, centered about midway between Iceland and southern Greenland, is deeper and larger than it was in September. The Azores High, centered near 34°N, 35°W, is only slightly weaker (at 1020 mb) than in the preceding month, but it has diminished in size.

WINDS. North of 40°N, the prevailing winds are westerly and generally of force 4 to 6 north of 50°N, and force 3 to 5 between 40° and 50°N. The exceptions are: southerly over the Norwegian Sea, southwesterly over the North Sea, Baltic Sea, and adjacent waters, variable near the Icelandic Low, and light (force-2) northwesterlies through north- to southeasterlies around the Davis Strait. South of 40°N, northeasterly winds prevail of force 3 to 4. Southeasterly force-3 winds blow near the Equator between South America and Africa. Northwesterly winds of force 2 to 3 are prevalent over the Mediterranean Sea.

GALES. Both the frequency of and the area subject to gales increase markedly over the previous few months. Winds of force 8 or more can be expected oceanwide north of about 40°N, with a frequency from 5 to over 20 percent. The highest frequencies occur over a small area south of Greenland's southern tip, the Greenland Sea, and the northern portion of the Norwegian Sea. An analysis of eight Ocean Station Vessels north of 40°N indicates that gales generally last less than 1 day over these waters.

EXTRATROPICAL CYCLONES. The temperature contrast off the Atlantic coast, from Labrador through the Carolinas, is conducive to cyclogenesis. Other principal areas of cyclogenesis lie over midocean within an egg-shaped area oriented in a northeast-southwest fashion and comprising a 250- to 300-mi-wide area between 56°N, 23°W, and 48°N, 37°W; over the Bay of Biscay; within the coastal area from Marseilles east-southeastward to Naples; over all but the extreme southern part of the Adriatic Sea; over the Skagerrak, the Kattegat, and the Baltic Sea to about 61°N; off the northern Norwegian coast; east of Iceland; and off the Denmark Strait coast of Greenland. There are more extratropical cyclones than in September, but primary storm tracks are similar, although most are displaced a little farther south. The secondary cyclone track over the northwestern Mediterranean area has lengthened and become of primary importance. Primary tracks are also found over North America from Kansas across the Great Lakes to James Bay, and from James Bay to the Labrador coast. From the Newfoundland-Labrador coasts, the main track is toward Iceland. Another shorter track exists, about 5° latitude south of the main track in midocean. A single track extends from south of Iceland to northern Norway. Occasionally, North Atlantic extratropical storms, being of considerable intensity, generate hurricane- or near-hurricane-force winds.

TROPICAL CYCLONES. The hurricane season continues into October, but after the middle of the month, the probability of a tropical storm occurrence diminishes rapidly. An average of 3 to 4 tropical storms will occur each 2 yr, and about half will develop to hurricane strength. The vast majority of the storms develop before the 21st of the month. Most October storms form over the western Caribbean, but some are spawned near the Lesser Antilles.

SEA HEIGHTS. During October, sea heights of 12 ft or more are usually encountered 10 percent or more of the time over the open ocean north of about 40°N (excluding most of the Norwegian Sea), over the Gulf of Lions, and over central Hudson Bay. An area of 20-percent frequency extends southward out of the Denmark Strait, then eastward south of Iceland to the Faeroe Islands, and westward around Kap Farvel into the Labrador Sea. The southernmost point of the southern boundary is about 57°N, near 35°W. A second small area, about 4° in diameter, is centered near 50°N, 40°W. The areas described above very closely approximate the 10-percent frequency for waves of 20 ft or greater.

VISIBILITY continues to improve during October, compared with the previous month. Frequencies of 10 percent or more of visibility less than 2 mi are now found in only three scattered areas--the southern Davis Strait and northern Labrador Sea, over waters due east of Newfoundland, and from the southern reaches of the Denmark Strait southeastward to the Faeroe Islands and then north-northeastward to the Greenland Sea. As in September, the cold waters north of Iceland entertain an area of 20- to 30-percent frequency of visibility less than 2 mi, and a small area (within this larger area and centered near 68°N, 18°W) where visibility less than 2 mi exceeds 30 percent of all observations.

NORTH PACIFIC, OCTOBER

WEATHER. October marks the transition to winter conditions over the northern latitudes of the North Pacific. The Aleutian Low, lying off Cape Newenham, Alaska, has deepened 4.5 mb (as compared to September) to 1002.5 mb, while the subtropical High has become a flat east-west ridge, centered roughly along the 33d parallel, containing a maximum pressure of about 1020 mb.

WINDS. Between 40° and 60°N, westerly winds predominate, with forces 4 to 6 most frequent. However, northwesterlies and northerlies prevail over the eastern Bering Sea, easterlies dominate the Gulf of Alaska, and winds off the coast of British Columbia normally blow from the southwesterly quarter. North of 60°N, the winds are northerly to northeasterly at force 3 to 5. From 30° to 40°N, directions are more variable, with northeasterly and northerly winds prevalent east of Honshu, and northwesterlies common east of the dateline, shifting to northerly near the California coast. Force-4 winds constitute the largest percent-

age frequency within the above latitudinal belt. The northeast trades, which average slightly less than force 4, prevail between the Equator and 30°N. Northerly force-3 winds are the general rule out from the Gulf of Tehuantepec. The winter monsoon is now well established over Asiatic waters, penetrating as far south as Indochina.

GALES. The chances of encountering winds of force 8 or higher increase appreciably in October, particularly in the middle and higher latitudes. The highest incidence of gales occurs between 48° and 56°N, from Kamchatka eastward to about 140°W, with over 10 percent of the wind observations over most of these waters revealing gales. Ships plying the central Bering Sea as far north as the 63d parallel are also laced by gale-force winds more than 10 percent of the time. There is a gradual decrease in frequency southward--gales are infrequent south of 30°N over the central ocean, 35°N over the western ocean, and about 44°N above eastern waters. Nevertheless, gales are observed between 5 and 10 percent of the time over the typhoon-troubled waters near Taiwan, and those southwest of Japan.

EXTRATROPICAL CYCLONES. The frequency and intensity of extratropical cyclones increase in October. The principal sources of storms, or cyclogenesis, are the Mongolia - Manchuria area and the seas south of Japan. Other areas are along the Aleutian Islands, and over the midocean slightly north of latitude 40°N. The primary storm tracks extend from across Sakhalin and south of Japan toward the Near Islands. From there, the track parallels the Aleutian Islands into the Gulf of Alaska. Another track comes out of the midocean source area into the Gulf of Alaska. A secondary track departs the Near Islands for the Bering Strait.

TROPICAL CYCLONES. Three or four tropical cyclones can be expected to develop over the tropical waters of the Far East. On the average, two or three reach typhoon intensity. Most of these tropical cyclones form at low latitudes in an area extending from the Philippine Islands to about 155°E. Their early movement is generally west-northwestward, and most recurve east of the Philippines or Taiwan and sweep up along the east coast of Japan. A smaller number move across the Philippines into the South China Sea; a still smaller number reach the Asiatic mainland.

In the tropical waters of the eastern North Pacific, tropical cyclones are less frequent than in September, averaging about two per year. Roughly half of these storms reach hurricane intensity at some time in their lives. October tropical cyclones follow less regular tracks than those of September. After developing off the coast of southern Mexico-Guatemala, or near the Revillagigedo Islands, a large percentage of these storms will move inland over Mexico, south of about 30°N.

SEA HEIGHTS. The frequency and area of high waves increase, especially over the northern shipping lanes. The area bounded by approximately 43°N, 160°E, 145°W, and the Aleutian Islands, has 12-ft or higher waves over 10 percent of the time. In general, the area from coast to coast between 30° and 55°N will have seas 12 ft or greater, 2 to 10 percent of the time.

VISIBILITY. Percentage frequencies of low visibility decrease in October. Visibility less than 2 mi occurs 10 percent or more of the time north of a line drawn from Ostrov Karaginski eastward to a point northeast of the Pribilofs, and then southwestward across the Fox Islands to a point near 42°N, 175°W. From there, the line extends eastward across the 155th meridian, and then northward to Kodiak Island.

NORTH ATLANTIC, NOVEMBER

WEATHER. While normally November is considered a transitional period between fall and winter weather over northern waters, this month occasionally develops some of the severest weather of the winter season. Most rough weather is confined to north of 45°N, except along the coast of the United States, where there is an increase in winter-type LOWs. Over the Great Lakes Region, two primary storm tracks--of Alberta and Colorado LOWs--converge into an area of maximum cyclone frequency, contributing in a large measure to rough weather toward the close of the Lakes' navigation season. The Icelandic Low (1002 mb) is still centered between Iceland and southern Greenland. The Azores High has shifted eastward and is centered near 33°N, 29°W; its central pressure has risen slightly to about 1021 mb.

WINDS north of 60°N are quite variable at about force 4 to 5, although these winds tend to come from the northerly quarter west of Iceland, and from the southerly quarter east of that island nation. Westerly winds, force 4 to 6, prevail over most of the ocean between 40° and 60°N. Between the latitudes of 30° and 40°N, force 3 to 4 winds are of variable direction, except east of the Azores, where a noticeable northerly component prevails. The northeast trades, averaging force 3 to 4, extend from 30°N southward to 10°N. Between 10°N and the Equator, southeasterlies (force 3) are predominant.

GALES. The frequency of gales over northern and middle latitudes increases substantially in November. Winds of force 8 or higher occur 10 percent or more of the time over most areas north of about 35°N over western waters; north of about 40°N over the central ocean; and north of about 44°N over eastern waters, including the southern half of the North Sea. A 10-percent frequency of gales is encountered on the Mediterranean only over the Gulf of Lions. Frequencies are generally less than 10 percent, however, over the waters between Iceland and southern Greenland (near the center of the Icelandic Low), over a relatively small area about 200 mi northwest of the western Irish coast, and over and south of the Irish Sea. Frequencies of 20 percent or more occur in the Davis Strait north of 63°N, south of Greenland in the vicinity of 55°N, 45°W, and over most of the Greenland and Norwegian Seas.

EXTRATROPICAL CYCLONES. The principal track of extratropical LOWs is northeastward from the waters off Cape Cod, across Newfoundland to Iceland, and then through the Norwegian Sea. Sometimes these

cyclones will approach Iceland from the central part of the North Atlantic Ocean. Other major tracks lead from Hudson Bay to the Davis Strait, and from the Gulf of Lions to Italy.

TROPICAL CYCLONES are infrequent in November. Usually, one storm in 3 yr may be expected, and about half will develop to hurricane intensity. Most of these storms develop over the Caribbean Sea or eastern Gulf of Mexico, and are soon following a northeasterly path out over the main body of the North Atlantic.

SEA HEIGHTS of 12 ft or more are encountered more than 10 percent of the time on most of the ocean north of about 40°N and south of the Davis Strait and the Norwegian Sea, and on the Mediterranean Sea in the Gulf of Lions and the northern Aegean Sea. The frequency increases to 20 percent or more over most of the waters between 47° and 60°N, and extending into the Denmark Strait.

VISIBILITY less than 2 mi reaches a frequency of 10 percent north of a line drawn from the waters around, and 200 mi south of, Kap Farvel west-northwestward to Saglik, Labrador (55 mi northwest of Cod Island); and north of another line extending from Angmagssalik, Greenland, to northwestern Iceland, then across land to the Vesturhorn (eastern Iceland), then eastward to 64°N, 07°W; it then stretches north-northeastward across the Norwegian Sea to the waters north of Norway. An area of frequencies exceeding 20 percent or more lies north of Iceland between 67° and 72°N, and westward from 05°W to Greenland.

NORTH PACIFIC, NOVEMBER

WEATHER. November is often a stormy month north of 35°N over western waters, and about 40°N over the eastern ocean. There have been years when November was the stormiest month of the winter season, but generally the weather is not too severe, and there may be quiet periods lasting several days. South of 40°N, the probability of severe extratropical storms diminishes rapidly with latitude. During November, the Aleutian Low, near 57°N, 170°W, is well established over northern latitudes, with a central pressure of 1000 mb. The Pacific subtropical High, at 1021 mb, is slightly stronger than in October and is centered near 33°N, 140°W. Off the Chinese coast, pressures are higher than during October because of the buildup of the cold Asiatic High.

WINDS. Over the ocean north of 55°N, northerly winds (force 4 to 6) prevail, except over the eastern Bering Sea, where winds are variable, and the Gulf of Alaska, where easterlies and northeasterlies are most common. With the exception of the area east of 140°W, where southerly and westerly winds are prevalent, westerly winds (force 4 to 6) predominate between 55° and 35°N. Variable winds near force 4 are most frequent between 35° and 25°N, except over the Yellow Sea and waters off Japan, where northerlies predominate. The northeast monsoon (affecting areas west of 140°E) and the northeast trades blow steadily at about force 4, south of 25°N. Lighter force 2 to 3 winds are the rule over the southern limits of the South China Sea, east of the Gulf of Siam. Northerly winds blow steadily out from the Gulf of Tehuantepec, off Mexico's south coast. They reach gale force between 5 and 10 percent of the time just west of the gulf.

GALES occur 5 percent or more of the time north of about 35°N. An area of 5- to 10-percent frequency is also found over the northern reaches of the South China Sea, including the Formosa Strait and the Luzon Strait, and west of the Gulf fo Tehuantepec, as mentioned above. Actually, a frequency of 10 percent or more is found over most of the waters north of 39°N, with the exception of the eastern Pacific east of 154°W (south of 50°N) and the waters east of the Kamchatka Peninsula. A small area of maximum frequency, where gales occur 20 percent or more of the time, is centered about 225 mi southeast of the southern tip of Kamchatka.

EXTRATROPICAL CYCLONES. The main storm tracks extend northeastward from the Japanese Islands to the western Aleutians, and then east-northeastward to the Gulf of Alaska. Another primary cyclone track enters the gulf from an area in the central ocean near 47°N, 169°W. In November, there are more LOWs passing over the Gulf of Alaska than any other part of the Northern Hemisphere; this is also true of 5 of the following 6 mo.

TROPICAL CYCLONES. On the average, two or three tropical cyclones develop over the western North Pacific in November. Two of these usually reach typhoon intensity. The region of most frequent formation is in the vicinity of the central and western Caroline Islands; the tropical cyclones either travel west-northwestward over the Philippines and the South China Sea, or recurve near 15°N, 132°E, to pass east of the Japanese Islands.

Tropical storm frequency over the eastern North Pacific drops rapidly for November, averaging about one every 3 yr. None have developed to hurricane intensity. Tropical storms very seldom occur in the central North Pacific--maybe one every 20 yr. When these late-season storms do develop in the eastern ocean, their direction of movement is usually more northerly than westerly.

SEA HEIGHTS. The area with 12-ft or greater seas and a frequency of 10 percent is bounded by the Aleutian Islands, 158°E, 43°N to 160°W, where the latitude drops to 35°N, and a line from 35°N, 150°W, to the Queen Charlotte Islands. A small area between Hong Kong and Taiwan is also affected, as is a large part of the Sea of Okhotsk. High-swell observations are found north of 30°N, with a tongue extending to the Equator east of the Hawaiian Islands. These observations are more frequent off the State of Washington coast, south of Kodiak Island, and east of the Kuril Islands.

VISIBILITY. Frequencies of low visibility (less than 2 mi) greater than 10 percent lie north of a line drawn from Mys Terpeniya, Sakhalin, eastward across the central Kurils, and then north-northeastward to the waters east of the Komandorskiye Islands. From there, the line stretches northeastward to St. Lawrence Island and the Seward Peninsula. Two smaller regions of 10-percent or greater frequency are centered over the Bering Sea, near 54°N, 173°W, and over the midlatitudes of the eastern North Pacific, near 46°N, 146°W.

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